Digitized by Arya Samaj Foundation Chennai and eGangotri

URNAL OF
HE ROYAL
ATISTICAL
OCIETY

OL. 116
1953

CC-0. In Public Domain. Panini Kanya Maha Vidyalaya Collection. Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

पुस्तकालय विज्ञान भवन, गुरुकुल कांगड़ी
विषय संख्या 519.905
पुस्तक संख्या J82J V.16
पञ्जिका संख्या 4254
पुस्तक पर सर्व प्रकार के चिन्ह लगाना वर्जित है । कोई सज्जन पन्द्रह दिन से अधिक समय तक पुस्तक अपने पास नहीं रख सकते ।

यह पुस्तक वितरित न की जाय
NOT TO BE ISSUED

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

सन्दर्भ ग्रन्थ
REFERENCE BOOK

~~454~~

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

110634

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

JOURNAL

OF THE

ROYAL

STATISTICAL SOCIETY

SERIES A (GENERAL)

CHECKED 1973

Founded 1834

Incorporated by Royal Charter 1887

Vol. CXVI—1953

LONDON :
ROYAL STATISTICAL SOCIETY
4, PORTUGAL STREET, W.C.2

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ROYAL STATISTICAL SOCIETY

Patron

HER MAJESTY THE QUEEN.

COUNCIL AND OFFICERS.—1952–53

Honorary Vice-Presidents
(having filled the Office of President)

The Rt. Hon. Viscount Samuel, G.C.B., G.B.E., D.C.L.
Sir Arthur L. Bowley, C.B.E., D.Litt., Sc.D., D.Sc., F.B.A.
H. Leak, C.B.E.
The Rt. Hon. Lord Beveridge, K.C.B., LL.D., D.Sc., F.B.A.
Ernest Charles Snow, C.B.E., D.Sc.
The Rt. Hon. Lord Woolton, P.C., C.H., D.L. LL.D.
*David Heron, D.Sc.
*Sir Geoffrey Heyworth.
*Professor A. Bradford Hill, C.B.E., D.Sc., Ph.D.

President
Sir Ronald Fisher, F.R.S.

Vice-Presidents
Professor G. A. Barnard.
E. C. Fieller.
Philip Lyle.
L. H. C. Tippett.

Other Members of Council
Professor R. G. D. Allen, O.B.E
F. J. Anscombe.
Professor M. S. Bartlett, D.Sc.
W. R. Buckland, Ph.D.
Professor D. G. Champernowne.
Professor E. Devons.
Iris Douglas.
R. F. Fowler, C.B.E.
R. F. George.
R. G. Glenday, M.C.
H. O. Hartley, Ph.D.
J. O. Irwin, Sc.D., D.Sc.
G. H. Jowett.
Professor M. G. Kendall, Sc.D.
W. P. D. Logan, M.D.
Sir George Maddex, K.B.E., F.I.A.
F. A. A. Menzler, C.B.E., F.I.A.
Dennis Newman.
E. D. Van Rest.
Professor J. H. Richardson, Ph.D.
J. Ryan, C.B.E., M.C.
L. G. K. Starke, F.I.A.
J. R. N. Stone, C.B.E.
A. W. Swan.
L. T. Wilkins.
J. Wishart, D.Sc.

Executive Committee
The President.
The Ex-President.
The Vice-Presidents.
The Hon. Secretaries.
The Hon. Treasurer.
J. O. Irwin, Sc.D., D.Sc.
Sir George Maddex, K.B.E., F.I.A.

519.905
R81J
V.116

Honorary Treasurer
R. F. Fowler, C.B.E.

Honorary Secretaries and Editors
R. F. George.
Philip Lyle.
Iris Douglas.

पुस्तकालय विज्ञान भवन
519.905
R81J
V.116

Honorary Foreign Secretary
R. F. George.

Secretary
Una M. Croker.

Librarian
J. A. King.

Bankers
Royal Bank of Scotland (Drummond's Branch), Charing Cross, London, S.W.1

Offices
4, Portugal Street, London, W.C.2.
(Telephone: Holborn 4283)

* Also Member of Council.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CONTENTS

VOL. CXVI—YEAR 1953

Part I, 1953

	PAGES
The Expansion of Statistics. The Inaugural Address of the President, Sir RONALD FISHER, F.R.S.	1–6
Proceedings of the Meeting	7–10
The Analysis of Economic Time-Series—Part I: Prices. By Professor M. G. KENDALL	11–25
Discussion on the Paper	25–34
The Price of Gold and the Purchasing Power of the Pound Sterling. By H. FRANKEL	35–46
United Kingdom: Comparison of Urban and Rural Retail Prices. By J. R. BELLERBY	47–56
Food Statistics. By W. D. STEDMAN JONES	57–84
Reviews of Books	85–98
Statistical and Current Notes	99–103
Obituary:	
A. D. WEBB	104
THEODORE C. TAYLOR	104
Statistical and Economic Articles in Recent Periodicals	105–110
Additions to Library	111–118
Periodical Returns: Revenue of the United Kingdom, 1952; Bank of England Weekly Return, 1952	119–121

Part II, 1953

	PAGES
Regional Variations in United Kingdom Incomes from Employment, 1948, By PHYLLIS DEANE	123–135
Discussion on the Paper	135–139
A Sampling Design used by the Ministry of Education. By G. F. PEAKER	140–159
Discussion on the Paper	159–165
A Note on the Relation between Intelligence and Parental Income. By A. M. WALKER	166–174
The Problem of Exceptional Samples in Agricultural Sample Surveys. By W. D. BURROWES	175–176
Bibliography of Applications of Mathematical Statistics to Economics, *Supplement for* 1950. By A. D. SCOTT	177–185
Wholesale Prices in 1952. By THE EDITOR of *The Statist*	186–190
Telecommunications Statistics. By A. HAZLEWOOD	191–202
Reviews of Books	203–217
Statistical and Current Notes	218–222
Statistical and Economic Articles in Recent Periodicals	223–228
Additions to Library	229–236

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Part III, 1953

	PAGES
Construction of an Index Number of Gilt-Edged Values. By M. S. RIX	237–251
Discussion on the Paper	251–255
Statistical Investigations of Labour Productivity in Cotton Spinning. By L. H. C. TIPPETT and P. D. VINCENT	256–267
Discussion on the Paper	267–271
The Treatment of Errors. By DUDLEY SEERS	272–274
The Industrial Wages Bill and Earnings of Operatives in 1935 and 1948. By H. LEAK	275–282
Criminal Statistics. By T. S. LODGE	283–297
Timber Statistics. By J. J. MACGREGOR	298–322
Reviews of Books	323–332
Statistical and Current Notes	333–334
Statistical and Economic Articles in Recent Periodicals	335–339
Additions to Library	340–344
Periodical Returns: Registration of the United Kingdom and Eire, 1948–1952	345–348

Part IV, 1953

	PAGES
An Experimental Study of Quota Sampling. By C. A. MOSER and A. STUART	349–394
Discussion on the Paper	394–405
A Comment on a Criterion of Efficiency in Local Administration	406–408
International Air Transport Statistics. By A. M. LESTER	409–423
Statistics relating to the Use of Land in the United Kingdom	424–430
Annual Report to the Council	431–450
Proceedings of the One Hundred and Nineteenth Annual General Meeting	451
Regulations of the Study Circle on Medical Statistics	452
Reviews of Books	453–469
Statistical and Current Notes	470–471
Statistical and Economic Articles in Recent Periodicals	472–475
Additions to the Library	476–479
Index to Vol. CXVI (1953)	480–483

NOTICE

THE Council of the Royal Statistical Society wish it to be understood that the Society is not responsible for the statements or opinions expressed in the Papers read before the Society or published in its *Journal*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

VOL. CXVI.] [PART I

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART I, 1953.

The Expansion of Statistics

[The Inaugural Address of the President, Sir Ronald Fisher, F.R.S., delivered to the Royal Statistical Society on November 19th, 1952]

Thirty or forty years ago it seemed to me a very strange thing that the branch of learning known as Applied Mathematics should fall into two so very unequal parts. On the one side, in the main stream of historical development, were the applications to Astronomy, Physics and Engineering, for which the Universities traditionally made provision by numerous courses in Mechanics, Optics, Electromagnetism, Hydrodynamics, Thermodynamics, and many more specialized subjects, which formed a solidly integrated body of teaching, and the backbone of the education received by the great body of students in Applied Mathematics. On the other side was a slender and tenuous branch of learning, stemming in its origins equally far back to Fermat and Pascal, yet almost neglected in the Universities, and intermittent in its historical development. Its brilliant efflorescence with De Moivre and Bayes, at a period when no one thought gambling to be disreputable, was later almost a handicap, requiring apologies from Laplace and de Morgan in the early nineteenth century. They would rather stress the solid social benefits, and the great commercial success, of the business of Insurance; and sought, rather fruitlessly, to find further social applications for so elegant a mathematical theory, in assessing the probability of correctness of the decisions arrived at by voting, of courts of justice and other committees.

The growth of Actuarial Science was, however, rather a parallel development than an offshoot of the theory of probability. Powerfully influenced by the practical importance of the accurate evaluation of life assurances and annuities, it owed more to the early workers in the Calculus of Finite Differences, especially to Newton, than to the early work in the Theory of Probability; to-day we can recognize that this indebtedness has been discharged with handsome interest, and I have often regretted that courses on the computational techniques of the Calculus of Finite Differences should be so seldom given to others than actuarial students.

The Theory of Errors sprang with equal independence from the practical need to grapple with the problems, at first sight fantastically difficult, confronting astronomers and surveyors, in the combination of observations. The extent to which Statistical Science was broadened and enlarged by this development has not been appreciated by writers on the Theory of Probability. Perhaps only a genius of the magnitude of Gauss could have introduced and consolidated so many new ideas. Unknowns, other than probabilities, were seen to require estimation. Observations had to be discussed that were not merely counts of frequencies, but quantitative measurements on a conceptual continuum. The normal distribution was introduced, not as the necessary consequence of a deductive mathematical argument, but by a choice resting on penetrating understanding of its essential properties. It was amid such extensions, and as part of a much larger whole, that the Theory of Probability began to acquire a genuine importance for human thought.

The diversity of the roots of what we can now recognize as a unitary discipline, and the successive extensions of concept and method as our abstract ideas have been, at one point after another, brought into integral connection with the real world—the world in which it is only in the light of experience, by experiment and observation, that we can guess the rules of our game of chance—are, as it seems to me, worthy of emphasis at the present time, if we are to seize and comprehend the much greater widening of ideas, and diversity of application which characterizes the intensification of statistical activity in the second quarter of the twentieth century.

A few years ago, in a short Presidential address to the International Biometric Society, I ventured to suggest that Statistical Science was the peculiar aspect of human progress which gave

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to the twentieth century its special character ; and indeed members of my present audience will know from their own personal and professional experience that it is to the statistician that the present age turns for what is most essential in all its more important activities. They are the "backroom boys" of every significant enterprise. In the all-important field of scientific research it is they who plan and design the experimental programmes, or the observational surveys, and it is they again who are called in to analyse the results, to assess the evidence, and to separate what is clearly demonstrated from what still requires confirmation. For the business of fact-finding in the fields of economics, sociology or vital statistics, that characteristic and intricately elaborated product of the theory of random sampling, namely, the *Sample Survey*, has shown itself to be economical certainly and of reliable accuracy, but more particularly to be expeditious and adaptable in comparison with older methods. In the field of productive industry that enterprising body known as the Quality Control Engineers, using statistical methods, sometimes of extreme simplicity, but with rapidly increasing refinement and sophistication of statistical techniques, has shown how to reconcile the *efficiency* of mass-production with the accentuated demands for *precision* and *reliability* of, for example, the aircraft industry. Perhaps the production during the last war of such a delicate and potentially dangerous appliance as the proximity fuse, and that by the hundred million, will serve to illustrate how enormously the industrial potentiality of mankind has been increased within a small part of our own lifetimes. The real threat of but a few years back that every aspect of our lives was destined to be harassed by gadget after gadget, constantly out of order and in need of repair, has certainly receded now that every industrial process can be geared to whatever degree of precision is thought to be requisite.

Though perhaps it yields its greatest dividends in the improvement of quality at the level of production, sampling theory is equally happily adaptable to commercial guarantees and acceptance procedures, where the types of tests known as Sequential have been especially successful. In the commercial field also, the possibility of gauging the intensity and tenacity of Consumer Preference promises to lead to a more beneficent or at least less reckless and wasteful use of the medium of advertisement. Already the machinery exists, though it can scarcely be said yet to be organized or unified, by which the actual requirements of that statistical aggregate, the consumer, can be competently ascertained, and transmitted along the whole chain, to the designer and the production engineer.

This rather tumultuous overflow of statistical techniques from the quiet backwaters of theoretical methodology, to which they belonged only a few years ago, into the working parts of going concerns of the largest size, suggests that hidden causes have been at work for much longer than the period of manifest efflorescence, preparing men's minds, and shaping the institutions through which they work, so that, quite suddenly when the academic tools had become sufficiently sharp and accurate, or, perhaps equally important, sufficiently realistic, there was no end to the number of applications impatiently awaiting methods which could, really, deliver the goods. With the aid of a few examples, drawn only from the story of "the improvement of natural knowledge", I propose indeed to suggest that the period of inconspicuous gestation extended through most of the nineteenth century, and was responsible for a goodly number of fundamental advances in subjects the students of which are quite unaware of their statistical origin.

In my first example the facts are, I believe, indisputable. Charles Lyell, the geologist, was born in 1797, and in 1830 there appeared the first of the three volumes of his celebrated *Principles of Geology*. The second volume was received by Darwin at Monte Video in 1832 during the outward voyage of the "Beagle", and no book could have been more stimulating for the theories which Darwin later formed. The third volume is dated 1833, three years after the first. The work is, of course, a scientific classic, a masterpiece of lucid and effective literary style, embodying proposals by the author of revolutionary importance, and preserving for readers of our own age the memorials of a scientific environment with its ideas and arguments so remarkably different from our own.

Geologists prior to Lyell had recognized the sequences of strata which we know as Primary and Secondary, using in the first place the regularity of order of superposition in the same locality. They observed, too, that particular components of these formations could be recognized, though far apart, by their characteristic fossils. They could not by these means recognize or establish the order among the Tertiary rocks, for, in the part of the world then accessible, these occur in patches, and not over wide areas overlying one another. Lyell determined the order and assigned to the successive rock masses the names they now bear by a purely statistical argument. A rich group

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of strata might yield so many as 1,000 recognizable fossil species, mostly marine molluscs. A certain number of these might be still living in the seas of some part of the world, or at least be morphologically indistinguishable from such a living species. It was as though a statistician had a recent census record without recorded ages, and a series of undated records of previous censuses in which some of the same individuals could be recognized. A knowledge of the Life Table would then give him estimates of the dates, and, even without the Life Table, he could set the series in chronological order, merely by comparing the proportion in each record of those who were still living.

With the aid of the eminent French conchologist M. Deshayes, Lyell proceeded to list the identified fossils occurring in one or more strata, and to ascertain the proportions now living. To a Sicilian group with 96 per cent. surviving he gave, later, the name of Pleistocene (mostly recent). Some sub-appenine Italian rocks, and the English Crag with about 40 per cent. of survivors, were called Pliocene (majority recent). Forty per cent. may seem to be a poor sort of majority, but no doubt scrutiny of the identifications continued after the name was first bestowed, and the separation of the Pleistocene must have further lowered the proportion of the remainder. The Miocene, meaning "minority recent", had 18 per cent., and the Eocene, "the dawn of the recent", only 3 or 4 per cent. of living species. Not only did Lyell immortalize these statistical estimates in the names still used for the great divisions of the Tertiary Series, but in an Appendix in his third volume he occupies no less than 56 pages with details of the classification of each particular form, and of the calculations based on the numbers counted. There can be no doubt that, at the time, the whole process, and its results, gave to Lyell the keenest intellectual satisfaction.

Now the point of this little history, its point for statisticians, is that the statistical argument by which this revolution in Geological Science was effected was almost immediately forgotten. In later editions of the *Principles* this great Appendix, in which so much labour had been expended, has disappeared; it survived indeed only two years. It had served its purpose; the ladder by which the height had been scaled could be kicked down. Geologists could quickly recognize a fossiliferous stratum by a few characteristic forms with clear morphological peculiarities. There was no need to wait for extensive collection, or statistical tabulation. Nor does it seem to have been thought that future geologists had anything to learn from the example, or the particular method, of Lyell's discovery. His designations of the Tertiary formations remain as records of a forgotten past, like fossils themselves, less intelligible to the geological students than the casts of sea-shells they extract from the rocks.

The obliteration of the Appendix, so decisive for readers of later editions, was presumably actuated by motives stronger than the desire to save space, and these motives have an importance for us in so far as they are characteristic of statistical inquiry. Among thousands of identifications it would be surprising if at least a hundred were not questionable. The state of the evidence on each of these would constantly change as better preserved or more complete specimens came to be scrutinized. The labour of bringing the list up to date would be great, new editions were frequent, and with the Tertiary succession clearly established, and in practical use by all, this labour would serve no immediate purpose. Moreover, Lyell could not say, as might a later geological evolutionist, "These minor differences do not matter, it is only a question of convention at what level of distinctness a new name is required", for he and his associates firmly refused to admit the possibility of the gradual transformation of one form into another. Any "real" difference must mean to them both extinction and creation, and must be given full weight in estimating the proportion of forms "still living".

An example of a not dissimilar character is on record from the early years of the present century. Johannes Schmidt of the Carlsberg Laboratory in Copenhagen was not only an ichthyologist, but also an assiduous biometrician, particularly interested in the numbers of vertebrae and fin-rays of the various species of fish he studied. Usually he was able to establish statistical differences between samples of the same species drawn from different localities; often even from different parts of the same fjord. With the eel, however, in which the variation in vertebra number is large, Schmidt found sensibly the same mean, and the same standard deviation, in samples drawn from all over Europe, from Iceland, from the Azores and from the Nile. He inferred that the eels of all these different river systems came from a common breeding-ground in the ocean, and it was a major triumph of the research vessel "Dana's" expedition to secure the young eel larvae from a limited region in the Western Atlantic, not far from the breeding-grounds of the different species of eel which inhabits the Eastern rivers of N. America and the Gulf of Mexico. Of course, "every

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

school boy knows", or has been told, about the discovery of the source of the elvers, but a veil has been drawn over the biometrical foundations of the discovery, and my zoological friends have seldom even heard of Schmidt's biometrical studies. One is led to wonder in how many other cases the true sources of important scientific advances have been obscured past recall.

It is easily seen, however, that statistical ideas, often vaguely apprehended, indeed, and sadly lacking in the clarity and facility supplied by a competent statistical technique, formed the silent background of the greatest scientific advances of the nineteenth century. In mid-century the turning-point of Physics was reached with the Kinetic Theory of Gases. The notion that the pressure exerted by a gas was kinetic in origin was, of course, older than Maxwell. It was, however, Maxwell's recognition of a three-dimensional Gaussian distribution, as the form appropriate for the velocity distribution for molecules of equal mass, that made possible calculations of the properties of the aggregate, and so converted an interesting speculation into a working quantitative theory, in terms of which diffusion, conduction of heat, and viscosity could be discussed, and their experimental values used to throw light on the molecular population. With an understanding of the mechanical basis of the gas laws, too, they were quickly seen, as by van der Waals, to be capable of a more accurate restatement. The statistical ideas so injected into physical theory remained, however, somewhat insulated in a specialized application until Willard Gibbs recognized the fundamental nature of Statistical Mechanics, and blazed the trail for the Quantum Mechanics of the present day.

The influence of statistical ideas upon the recognition in Biology of the Theory of Natural Selection is more intricate, and requires probably a fuller examination than I shall be able to give it. The argument was manifestly a statistical one, but put forward so far in advance of the appropriate technical developments that it is only in recent years that writers such as Mather and Lerner have made a start in giving a rational account of the application of deliberate selection to animal and plant improvement. Indeed, Darwin's exposition, as I pointed out some years ago, was very gravely encumbered by the contemporary belief in Blending Inheritance, just as Lyell had been encumbered by the belief in Special Creation. To put across a subtle argument, of unfamiliar form, from among these entanglements certainly required all of Darwin's patience and pertinacity, and was perhaps only possible by reason of his wealth of detailed knowledge. In spite of the widespread consent and conviction which he won, the next two generations saw among theoretical workers in Biology quite incredible confusion of thought on the issues raised by Darwin, echoes of which are still audible; and there were periods, such as the turn of the century in this country, when only a minority would dare to express their belief in his theory. All this can be understood on the view that the force of Darwin's argument lay in statistical considerations with which the biological world had no opportunity for many decades to become familiar.

It must seem strange in view of Quetelet's early advocacy of Statistics as an educational discipline, that so many leading, and by the standards of their time, well educated, men were quite unaware that they had anything to learn in this field. Perhaps its name was too closely associated with politics and affairs of State, to attract those retiring and philosophic men who were inclined to give their lives to Science. It seems almost certain, however, that Gregor Mendel had never heard of Quetelet during his studies at Vienna (about 1855) or elsewhere. He recognized for himself that one of the important novelties in his approach to the study of inheritance was the use of statistical enumerations, and William Bateson, whom no one could suspect of being prejudiced in favour of statistical methods, called attention to the same circumstance. Yet much that Mendel needed and that was apparently beyond his reach could have been found in Quetelet, or indeed in the earlier eighteenth century authors. Moreover, Mendel was a well-read and studious man. I cannot doubt that although the biological teaching given in Vienna in the mid-nineteenth century was not worse than that given elsewhere—not worse we might say than much that is still given a hundred years later—yet it left Mendel with not an inkling that any of the puzzles he might encounter in the course of Biological Research had ever been helpfully considered and discussed by writers on Statistics. Mendel's use of Statistics in his great discovery was yet another sporadic outburst quite independent of the academic tradition.

I cannot, however, leave the question of Natural Selection without mention of Malthus, whose distinguished part in the foundation of this Society must predispose us in his favour. Both Darwin and Wallace ascribe their first confident appreciation of the potency of Natural Selection, not to personal contact with Malthus, but to the effects of casually reading his Essay on Population.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

How easy it would be to say, "Here is the source of that subtle statistical argument which convinced both Darwin and Wallace that they had uncovered the effective cause of Organic Evolution". I do not say it, because I do not believe it. What is there in the Essay to have this effect? There is the doctrine of excessive reproduction; i.e., that in Man, the species tends to produce more offspring than would be required for a stationary population. A most important fact for human policy; but what is the realistic and philosophic observer of Nature to make of it? He sees species such as thrushes with four eggs in the year, or foxgloves with ten thousand seeds each showing a reproductive activity about equal to the rate of elimination. If the reproduction falls below this level the numbers in the species will fall off, as must on the whole be the case more frequently than not ; but if in more favourable cases fewer die than are reproduced the numbers will go up. If we believe, as I should concede we have a right to do, that generally the density of each species is somehow stabilized, then we shall infer, though we shall not actually observe, that an increase in population will generally make it harder to survive, or to breed, and that a decrease will generally make life easier. We do not, however, see these additional checks to population at work ; they are rather subtle inferences, and the naturalist will not be tempted to label them "misery and vice". These are not the terms which spontaneously come to mind in considering crowded communities of, for example, winkles, or primroses; nor, of course, is "moral restraint" any more appropriate.

Yet something in Malthus undoubtedly influenced both Darwin and Wallace, for they begin at once to sketch pictures of a very unrealistic world in which animals reproduce, but do not die, at least until after they have reproduced abundantly—pictures in which the planet's land area is overrun with elephants, and in which the volume of the oceans is insufficient to accommodate all the herrings. This is certainly due to Malthus, but it is scarcely his logic but his rhetoric, which has gone to their heads. In truth, when I try to explain the Theory of Natural Selection to students, the phrases I find least helpful are those rather journalistic slogans, "The Struggle for Existence" and "The Survival of the Fittest". Each, of course, has a defensible meaning, but it is, I fear, only their dramatic violence that makes them effective.

Now it is very natural to the human race, and very unphilosophical, to imagine that results of towering and majestic importance, such as the evolution of living creatures, must be brought about by equally powerful or violent causes. If we can imagine my winkles, or my primroses, *tense with struggle*, red in their non-existent teeth and claws, it becomes easier to believe that great things are happening to them, that they are being hammered into shape by cosmic forces. Whereas all we know is that each is living its own quiet life, with the life Table and the rates of reproduction characteristic of its genotype, and that for this reason, and for no other, these species are probably changing, imperceptibly slowly, but with a speed sufficient to make them perceptibly different if they keep it up for some millions, or tens of millions, of years. Natural Selection has no need of all this "Sound and Fury, signifying nothing". But Darwin and Wallace, faced with the problem of getting across a doctrine, in many ways obscure, even to themselves, to a rather thick-headed audience by no means predisposed in its favour, must have felt greatly heartened by Malthus' eloquence in depicting the violence of the effects of the reproductive urge in mankind, and by the feeling that here was a natural agency really competent to bring about the great evolutionary effects they had in view.

These at least are my reasons for not tracing the peculiarly statistical nature of the Theory of Natural Selection to the distinguished statistician who in fact inspired both its discoverers. Its sequel through Galton and the mathematical study of Evolution is clearer than its origin. Statistical mathematics is to-day a well-established necessity as much in the understanding of populations and their natural evolution as in that of the technique of animal and plant improvement.

My epilogue and moral lie in the recent history of this Society itself, of which I owe the facts I can give to our Secretary. How has our organization risen to the height of its great opportunity? If we survey the increase in our numbers, over the last fifty years available for comparison, the course of events revealed is very instructive. From 1902 to 1927 the number of Fellows increased from 932 to 1,074, an increase of 142, or, over the twenty-five years, an annual rate of increase of 0·58 per cent. (Speaking to an instructed body I need make no hesitation, or elaborate explanation, if I calculate such a rate of increase as a divided difference of the natural logarithms.) The second twenty-five years, 1927 to 1952, brings the number (taken this year in April instead of December) up to 2,343, and gives an average rate of relative increase, not of 0·58 per cent. but of 3·12 per cent., more than 5 times as fast. Further, the last five years of these twenty-five has a higher rate of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

increase still, namely of 4·88 per cent. Whereas most organisms, and most societies, grow relatively more slowly as they get older and larger, our own old and large Society shows a relative growth rate characteristic of extreme youth.

Our Society has grown not only in size, but also in variety, by budding, I am glad to say, rather than by fission. Our Study Section dates from 1928; its last five years of growth from 194 to 284 has an annual increase of 7·62 per cent. as compared with 4·88 per cent. for the Society as a whole. The Research Section, founded in 1933, has in the last five years increased from 266 to 580, or at the rate of 15·59 per cent., a figure closely rivalled by the numbers of Fellows of the Society in the Industrial Applications Section, which dates from 1942, and has in the last five years increased at the rate of 14·95 per cent. per annum. The extraordinary performance of the Research Section indicates perhaps where the growth hormones are coming from, and where they are still richest.

These Sections have been founded originally and primarily for the sake of holding additional meetings. To the eight standard meetings of the Society, which still indeed attract the largest numbers, have been added eight or nine or even fifteen meetings of the Study Section. With the Research Section we have four more, about as well attended as those of the main Society, and thirty to forty meetings a year more with the Section of Industrial Applications. Over twenty-five years the total number of meetings has increased about seven-fold, say 7·78 per cent. on an annual average, as compared with a total membership increase of 3·12 per cent. over the same period.

From 1934 the regular publication of our Journal has been duplicated by the formation of Series B (*Methodological*), alongside of Series A, now termed *General*. In 1946 the page size of both series was increased by about 50 per cent., to their great advantage, both at the separate and at the bound stage. Series B is among other things the natural repository for the Proceedings of the Research Section, and has become a journal of the first importance for Mathematical Statistics. This year a third publication has been launched under the name of *Applied Statistics*, for which Mr. Tippett tells me the subscription list is already about 1,250—a figure large enough to make many scientific Journals envious. The needs of the Industrial Applications Section will there be met, I confidently expect, on a self-sustaining basis. Yet, unlike meetings, which are a comparatively economical form of activity, publications are, at the present time, quite inevitably costly. And the only really "mournful number" which I have to offer this evening is that in 1951 our two Journals together cost the Society something approaching £7,000. How this sort of thing is done on our annual subscription is for our very expert Treasurer to explain. The growing-pains of our renascent Society must, however, clearly be distinguished from the concurrent depreciation of the currency.

I can submit, therefore, with this little record before you, that our Society has taken an appropriately vigorous part in this tidal movement of our century, which I have ventured to call the Expansion of Statistics; and that there is every prospect that it will continue to exercise, in developments not yet to be foreseen, a wise and helpful initiative.

PROCEEDINGS OF THE MEETING

Professor BRADFORD HILL (Past-President) in proposing the vote of thanks: At the joint week-end meeting of the Royal Statistical Society and the Manchester Statistical Society held last September I was bullied into making an after-dinner speech. Afterwards the Senior Honorary Secretary of our Society remarked, "I am astonished how you appear to make relevant, stories which are totally irrelevant". I am still not sure whether I was offered a compliment or an insult. However that may be, I shall this afternoon seriously expose myself to risk again. In proposing this vote of thanks—without falling into the error of discussing a presidential address—I shall first of all consider the subject of German measles. The line of thought flows, I think, from the President's reference, in discussing the 19th century growth of statistics, to "a period of inconspicuous gestation" which was "responsible for a goodly number of fundamental advances in subjects the students of which are quite unaware of their statistical origin".

The story of German measles is this: Long regarded as a disease of little, if any, importance—merely a source of minor annoyance to parents and schools—it sprang into notoriety early in the second world war. The change lay in the acute observation of physicians in Australia. An attack of rubella taking place in an expectant mother in the early stages of her pregnancy could, it appeared, produce seriously damaging congenital defects in the child to be born. The infant might be affected in its sight, in its hearing, or in the functioning of its heart. Such cases have since been reported from many parts of the world, and though the story is still but half told and the problems connected with it only partially solved, there is, I think, no doubt of its central truth.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

This clearly might have been something new in medicine—perhaps, for instance, the virus causing German measles had changed its character at this time. This is where the statistical aspect of the story comes in. In the censuses of Australia—as in this country for many years—one of the questions asked of the population has been the incidence of infirmities, including deaf-mutism. One of our overseas Fellows, Dr. H. O. Lancaster, has studied these data (*Brit. Med. Journ.*, 1951, ii, 1429). He shows how in New South Wales at the census of 1911 the number of deaf-mutes was curiously and conspicuously high in the age-group 10–14. This, naturally, did not escape the census statisticians at the time, but they were—not unreasonably—inclined to ascribe the excess to a more complete enumeration of the deaf at the school ages.

Ten years later, however, in the census of 1921, the peak had moved on to the age-group 20–24. In other words it related to the same cohort. The previous explanation would not hold, and the statistician in charge was then moved to write "the age-incidence of the deaf-mutism varies in such a manner that it is apparent that the cause of the disability is of variable intensity, and there is some evidence to suggest that the increase in incidence of deaf-mutism at certain ages synchronizes with the occurrence of epidemic diseases, such as scarlet fever, diphtheria, measles, and whooping cough".

Passing from these census data Lancaster has also analysed the years of birth of children who were born deaf and who were admitted to certain institutions. A single quotation will serve my purpose. In such an institution in New South Wales the number of children who had been born in the 5 years 1894–98 gave an annual average of 15; in the 5 years 1900–1904 the average was 12. For the one year 1899 the number born was 70. There is, finally, "definite knowledge of a great epidemic of rubella throughout Australasia" in 1898.

The moral of the story is this. It is desperately easy to be wise after the event, but in the census returns and in the institutional data there is clear statistical evidence which might, with the aid of an epidemiological survey, have brought to light the phenomenon of the effects of rubella in pregnancy many years before the alert clinical mind detected it. The statistical origin was there but, as in the examples given us by the President, the relevant gestation period remained inconspicuous.

Turning to Sir Ronald's discussion of the expansion of, and within, our Society there is one point that I find a little disturbing. He says we—as a Society—reveal "a relative growth rate characteristic of extreme youth". Yet in his classic treatise on the Genetical Theory of Natural Selection, which as a young man I had the temerity to review for the Society's Journal, he drew attention to the infertility of the "best people" in civilized communities. He asserted that the really eminent breed freely only in a "barbarian" environment! Speculation as to how we reconcile these observations would bring me perilously near to discussion of a presidential address. I pass rapidly to topics safer, albeit duller, than that of reproduction.

As a slight amplification of what Sir Ronald has said of our meetings I might perhaps refer to a study I once made of the pre-war attendances at them. This was inspired by a semi-jocular statement that any experienced Fellow coming late to one of the Society's meetings—then held in the hall of the Royal Society of Arts—could determine precisely the subject-matter of the paper which was being read by the size of the audience. "If he should experience difficulty in finding a comfortable seat there is no doubt . . . that the intricacies of finance are under discussion; if . . . he observes a somewhat sparsely filled hall it is more than likely that the statistics at issue are those of life and death; . . . if he is faced with an embarrassingly empty room it is certain that the exponent of mathematical methods is at the reader's desk".

On the whole statistical analysis confirmed the impression. In 1926 to 1934 papers devoted to prices, commerce and finance attracted an average of between 80 and 90 Fellows and visitors, vital statistics an average of only 61. But at that time too few mathematical papers were read to give a mean upon which one could place any reliance. How great is the change to-day, a change due in no small measure to the influence of our President.

Looking further back in time I had occasion recently, in connection with the Society's acquisition of new premises, to consult the Council's annual report for 1886. I found there a suggestion from a Fellow that fortunately was *not* adopted. He had noticed, he said, "that in Government returns errors occurred which were repeated from year to year, and it would be helpful to the departments and useful to the public if the Society had a Committee to which all blue-books might be referred which contained statistical returns". I do not suggest that the many distinguished civil servants whom we number amongst our Fellows make errors to-day on every page of their innumerable publications, but yet it is, I submit, a matter for quiet rejoicing that the "expansion of statistics" within the Society did not take that particular turn.

On the other hand we may find a little curious the way in which some persons reacted, at this same date, to the suggestion that "a limited number of Fellows specially interested" might obtain

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

"on application two or three days in advance copies of the papers to be read at the evening meetings". Not only was strong objection made to persons being able to come to the meetings with ready rapier or bludgeon—a habit to which we are so accustomed to-day—but one future president protested that the scheme was impossible since on two occasions the papers he had to read on the Tuesday were not even begun on the previous Friday evening! We are, I fear, unlikely to see the Society's Honorary Officers and Council exhibit again such pleasant acts of faith and hope.

Lastly in my delvings into the past I turned, deliberately, to the Society's Journal for 1890. The first paper to be published that year had as its subject the Accumulation of Capital in the United Kingdom. That subject does appear to me—without too violently stretching the imagination—to be relevant to our meeting to-day. One month earlier, on February 17th, 1890, the United Kingdom, and indeed the whole statistical world, had received a somewhat important addition to its capital. A small baby set out upon a venturous and tempestuous voyage under the names of Ronald Aylmer Fisher. We are fortunate in this country that we have been able to keep this capital intact and at home, while for a generation we have exported the interest throughout the world—the flow of new methods, the flow of new discoveries, the flow of articles, books, disciples and teachers. There can be no part of the world today which deals with the statistical approach in which the name of R. A. Fisher is not known. I do not go so far as to say that the name is always loved and revered. I suspect that University students may, just occasionally, sigh at hearing it, that arithmeticians may sometimes even cross themselves. But it is difficult, perhaps impossible, for any statistician to-day to act, or even think, professionally without, consciously or unconsciously, playing at least some small part in what Udny Yule happily called this "Piscatorial era". How valuable it would be if some historically-minded statistician, or statistically-minded historian, would write a full history of this expansion and development of statistics.

The inaugural address of another President—of Section F of the British Association, which was held at Birmingham in 1886—ends with these words: " . . . the lessons of statistics may not in all cases have been universally received or practically laid to heart; the ever-varying conditions of Society may enforce a constant change in the appearance of social phenomena, and may lend an appearance of uncertainty to our conclusions, but it is not in this place, nor is it at the present time, that we need fear to meet the question, 'What has the Science which you are investigating done for the good of mankind?' ".

It is my privilege and pleasure to propose this vote of thanks to the President for his address. In making the proposal I would echo those words. Our subject is still expanding; it is, as he has stressed, encroaching upon new fields and upon new problems. Our Society grows in numbers; more important, it grows, as he has pointed out, in its activities. Lastly, we have today Sir Ronald Fisher as our President. We may, I submit, repeat with satisfaction and with confidence that it is not in this place, it is not at this time, that we should fear to meet the question, "What has the Science which you are investigating done for the good of mankind?".

Sir Geoffrey Heyworth (previous Past-President), in seconding the vote of thanks: By singling out the 19th century as a period of inconspicuous gestation which prepared fundamental advances in scientific subjects, the President has reminded us of a feature, frequently overlooked, which is common to advancement in all fields of scientific knowledge. Practice and theory seldom synchronize precisely. In some cases we have used the tool before establishing the principles by which it works. For instance, the plumb line was in use long before Newton propounded his theory of gravity. In other cases the establishment of principle has preceded practice. The steam engine was first put to practical use 250 years ago: but the principles of its operation were established 1800 years earlier. A new planet was discovered 100 years ago, a year after the mathematicians had argued that it must exist. In modern times the explosion of the first experimental atomic bomb in the United States has afforded the most remarkable proof of the abstract reasoning of the physicist. A large part of scientific progress has been accomplished by one method or the other—practice first, principle afterwards, or principle first and practice afterwards: but rarely practice and principle simultaneously.

In very many fields the theoretical advance has subsequently been put to practical use—as in the case of Lyell's geological classification—by skilled practitioners who have no need to remember the historical origins of their practical methods, even if they ever knew them. How many practising engineers, who use logarithms or their equivalent slide rules daily, could write down the formula by which logarithms are calculated? How many actuaries have in fact constructed a mortality table for general use? How many banking experts remember how and when the Bankers' Clearing House started? How many students of economics, brought up in the traditions of Marshall and Keynes, have actually read the works of Adam Smith, Ricardo, and the other giants of the past,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

who established the system of thought on which modern economics is built? In everyday matters the theoretical aspect is, and must be, subservient to practical application in such a way that the work of the earliest pioneers is bound to be forgotten or ignored by all except a few students of the evolution of scientific thought.

In antiquity, advances in science were largely based on intellectual or artistic motives. Only of the last 400 years can it be said that economic motives have provided the stimulus. Perhaps that is why the development of an important branch of the science of statistics—its application to social studies—has been so tardy. But there are other reasons. Sir Ronald referred in his address to the use of statistics in the field of commerce. In particular he mentioned the machinery by which "the actual requirements of that statistical aggregate, the consumer, can be competently ascertained and transmitted along the whole chain to the designer and the production engineer". It would be wise I think not to attribute too much to the power of statistical method. There are many factors which cannot be measured except historically; and history, even in statistics, does not exactly repeat itself. In the commercial field we can say, for example, that according to market research there is an established market for a certain brand of article; we can invent a new, better and cheaper brand; but we cannot be quite sure that the new article will entirely supplant the old in a given period of time.

There are certain factors, such as changes of fashion, which are incommensurable. We can tell you by statistics how far a new design of textiles has already penetrated a market in Tropical Africa, but we cannot tell you purely by statistical methods how far it is likely to penetrate in the future. The business man and industrialist have therefore to rely to some extent—I am glad to say a diminishing extent—on an ability to forecast the reactions of the consumer, an ability which we may call judgment or flair, or whatever other name you agree to give to a quality we have not yet succeeded in defining. In most fields the use of statistical methods of forecasting is increasing, enabling us to place possibly less reliance on judgment or flair. But there are still some forms of activity in which business sense or a broad economic judgment overrides the weight of statistical evidence.

It so happens that in my own business I can look back forty years because my early apprenticeship was served in the department concerned—amongst other things—with forecasting. Before the first world war there were broadly two schools—"the past experience school" and "the flair school". Neither had any opinion of the other. The past experience school made use of statistics in what I now see was an unimaginative way. The flair school would have nothing to do with statistics at all.

Both schools emerged red-faced from the post-first-war slump. The climate was favourable for a new approach. It began to be recognized that there was scope for statistics and for flair, and that the one was not the enemy of the other. The statisticians made large gains at this time and laid claim to more territory than they were able to consolidate—particularly in the field of pre-determination of consumer acceptance. The next phase saw further improvement of statistical tools, bringing with it the perhaps unexpected reward in added respect from the flair school.

Today I like to think that we have now reached the stage when we can say with confidence that the statisticians and the men who have to bring in the element of judgment work together as a team—with that respect for each other that is the secret of successful team working.

I should perhaps have added that in the post-second-war period a new element enters into industrial forecasting. Government controls extend over a large area. Changes in these controls have far-reaching consequences. It is obviously desirable to attempt to foresee what and when arbitrary changes are likely to occur. Does this territory belong entirely to the flair school, or should the statisticians claim some of it on the grounds that it is the backroom boys of Central Government that largely determine these arbitrary decisions?

The President has referred to the current accelerated rate of growth of membership of this Society. I suggest that industry and commerce have played their full part in that growth, and are likely to continue to do so.

The vote of thanks was carried unanimously.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Mir Maswood Ali.
Kwaku Baprui Asante.
Gerald Malcolm Bennett.
John Richard Bennett.
James Berry.
George Richmond Langdale.
Alcuin Williams Lehman.
Yves Lemarié.
Peter Owen Lewis.
Norman Harrison Leyland.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Parimal Biswas.
Chester Ittner Bliss.
Stuart Ashley Bowes.
Cyril Samuel Breslauer.
K. Joseph Chacko.
Harry Stagg Coblentz.
Elizabeth Colegrove.
Alexander Cubie Copeland.
D. van Dantzig.
Stephen Trevor David.
Leopold Dor.
John Draper.
James Eldridge.
Farid Fahmy Elmasry.
Mohamed Farid Elnaby.
Joseph René Etienne.
Laurie Frederick Fox.
Frederick Denis Gill.
Geoffrey Mitchell Goatman.
Richard Hacklett Goodman.
Lawrence John Gorham.
Donald Goulding.
Eunice Hainey.
Richard Sutherland Hall.
Rupert Jackson Harewood.
Ian Gordon Heslop.
Alfred Donald Hewitt.
David Hewitt.
Ian David Hill.
George Edward Hodnett.
Peter Martin Hooper.
Khondkar Manwar Hossain.
Alastair James Howie.
Norman Alfred Huttly.
Bhanoo Shashikant Jai.
Peter Thomas Jenkins.
William Wood Jones.
Kim Teck Lim.
Margaret Helen Loraine.
Dennis Albert Lury.
Michael St. George Lyster.
Rita Joy Maurice.
George Eric Mellor.
Gerald Miles.
Violet Marjorie Mussett.
John Rowan Nesbit.
Stanley Oglesby.
Soon Ann Ong.
Drayton Salisbury Palmer.
Kenneth James Radford.
K. S. Rao.
Cyril Douglas Rich.
Elsie Royle.
Francis Thomas Russell.
Josephine Salkind.
Robert Sydney Skinner.
Hubert Alan Smith.
John Squire.
Lilli Stein.
David Macdonald Swan.
Alastair William Gibson Taylor.
William Arthur Tompkins.
Hugh Douglas Turnbull.
Jeanine Ulmo.
Henry Richard William Watkins.
Geoffrey Stuart Watson.
Norman Leonard Webb.
Arthur Leslie Alabaster West.
Howard James George Whitton.
Samuel S. Wilks.
Thomas Eifion Hopkins Williams.
Harry Frederick Woolrich.
Yamauti Ziro.

Corporate Representatives

Cecil Howard Brand, *representing* Vauxhall Motors Ltd.
George Bernard Audley, *representing* Hulton Press Ltd.
Lawrence Victor Fisher, *representing* Hurst & Son Ltd.
Kenneth Vernon Smith, *representing* The Railway Executive

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Analysis of Economic Time-Series—Part I: Prices

By M. G. Kendall

Division of Research Techniques, London School of Economics

(Read before the Royal Statistical Society, December 17th, 1952, Professor A. Bradford Hill, C.B.E., Ex-President, in the Chair)

Introduction and Summary

1. It has been customary to analyse an economic time-series by extracting from it a long-term movement, or trend, for separate study and then scrutinizing the residual portion for short-term oscillatory movements and random fluctuations. The assumption latent in this procedure is that the long-term and short-term movements are due to separate causal influences and therefore that the mathematical process of analysis corresponds more or less roughly to a real distinction of type in the generative system. When it began to appear that the classical method of analyzing stationary economic fluctuations into cycles and residual elements broke down, and that better accounts of such movements were given by autoregressive schemes in which the disturbance element played an integral part, it was an easy step to proceed one stage further, and to enquire whether the so-called trend in a series was in fact separable from the short-term movements, or whether it should be regarded as generated by a set of forces which also gave rise to the short-term movements.

2. The work described in the present paper sprang from this idea. It was necessary in the first place to find suitable material on which to test it and I give below particulars of 22 price-series, ranging from 486 terms at weekly intervals to 2,387 terms at weekly intervals, which were chosen for the purpose. I began to construct models and to fit them to these data and also to other series which are not mentioned in this paper; but before the work had gone very far it appeared that the pattern of events in the price series was much less systematic than is generally believed. This is perhaps the most significant part of the present paper. I shall not have space to deal with the corresponding phenomenon in production data, and shall mention only incidentally the problem of trend fitting.

3. Broadly speaking the results are these:

(*a*) In series of prices which are observed at fairly close intervals the random changes from one term to the next are so large as to swamp any systematic effect which may be present. The data behave almost like wandering series.

(*b*) It is therefore difficult to distinguish by statistical methods between a genuine wandering series and one wherein the systematic element is weak.

(*c*) Until some way has been found of circumventing this difficulty, trend fitting, and perhaps the fitting of any model, is a highly hazardous undertaking. It may be possible for an econometrician to test whether the data agree with a hypothesis suggested by prior analysis, but it may be impossible to discriminate between quite different hypotheses which all fit the data.

(*d*) There is experimental evidence and theoretical support for the belief that aggregative index numbers behave more systematically than their components. This *might* be due to the reduction of the random elements by averaging and the consequent emergence of systematic constituents; but it could equally well be due to chance. If it is, there will appear spurious time-correlations in aggregative series and the use of index-numbers in econometric work needs extensive reconsideration.

(*e*) An analysis of stock-exchange movements revealed little serial correlation within series and little lag correlation between series. Unless individual stocks behave differently from the average of similar stocks, there is no hope of being able to predict movements on the exchange for a week ahead without extraneous information.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Data

4. For the purposes of this study I used 22 economic series as follows:

Actuaries' Index of Industrial Share Prices	*Period*	*Interval*	*Number of Terms*
1. Banks and Discount Companies	1928–1938	Week	486
2. Insurance Companies	,,	,,	,,
3. Investment Trusts	,,	,,	,,
4. Building Materials	,,	,,	,,
5. Coal	,,	,,	,,
6. Cotton	,,	,,	,,
7. Electric Light and Power	,,	,,	,,
8. Gas	,,	,,	,,
9. Iron and Steel	,,	,,	,,
10. Oil	,,	,,	,,
11. Total Industrial Productive	,,	,,	,,
12. Home Rails	,,	,,	,,
13. Shipping	,,	,,	,,
14. Stores and Catering	,,	,,	,,
15. Total Industrial Distributive	,,	,,	,,
16. Breweries and Distilleries	,,	,,	,,
17. Miscellaneous	,,	,,	,,
18. Total Industrial Miscellaneous	,,	,,	,,
19. Industrials (all classes combined)	,,	,,	,,
20. Basic cash wheat at Chicago in cents per bushel	Jan., 1883–Sept., 1934 (excluding 1915–1920 inclusive; one missing value interpolated for 10.3.1933)	,,	2,387
21. Monthly average of preceding series	Jan., 1883–Sept., 1934 (excluding 1915–1920)	Month	548
22. Spot cotton at New York in cents per pound	Aug., 1816–Jan., 1951 (excluding 1861–1866 and 1914–20; one missing value for Oct., 1857, inserted as average of the two neighbouring months)	,,	1,446

Sources

For the actuaries' indices I am indebted to the Institute and Faculty of Actuaries who allowed me to extract the figures from the Institute's records.

Series 20 and 21 are taken from *Wheat Studies of the Food Research Institute*, vol. 11, No. 3, November, 1934 (Stanford University, California).

Series 22 is taken from *Statistics on Cotton and Related Data*, U.S. Department of Agriculture, Bureau of Agricultural Economics, Statistical Bulletin, No. 99, Washington, D.C., June, 1951.

5. The golden rule in publishing work on time-series is to give the original data. To do so in this case would have required about thirty pages of journal. I shall, however, be glad to make available copies of the series or the cards on which they have been punched. A good many of the secondary statistics are presented below but here also the working sheets are available to any responsible person who is interested. So far as possible I have not "edited" any of the series even where there was some case for making the attempt; but in some instances I have omitted war periods and should have been compelled to do so by the lack of data. All such omissions are indicated above.

Analysis of the Price Data

The Chicago Wheat Series (20 *and* 21)

6. Although the wheat-price series was not the first I examined it is useful to begin an expository account by considering it because it is a long series of prices wherein little or no element of aggrega-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

tion enters. The Stanford Wheat Studies from which the data were taken give graphs of the series. They are unfortunately too long to reproduce on a page of this size.*

From the primary data the series of 2,379 first differences were constructed and a frequency distribution formed which is given as the marginal column in Table 1. It was here that the first fact of significance emerged, for the resulting distribution had nearly perfect symmetry and an appearance of approximate normality. The bivariate distribution of one difference against the next succeeding difference is even more illuminating. Table 1 is a condensed version and presents on the face of it an excellent picture of independence; on a regression diagram the two lines would almost coincide with the variate axes.

7. The decision to use first differences instead of the original series was not an arbitrary one. When a price is fixed on a free market both parties know what was the price of the previous transactions and use that price as a starting point for negotiation. It is the change, not the absolute value, which constitutes the fundamental element in the price determination. One can think of exceptions, perhaps, but for the commodities I am discussing they are not relevant.

8. At first sight the implications of these results are disturbing. If the series is homogeneous, it seems that the change in price from one week to the next is practically independent of the change from that week to the week after. This alone is enough to show that it is impossible to predict the price from week to week from the series itself. And if the series really is wandering, any systematic movements such as trends or cycles which may be "observed" in such series are illusory. The series looks like a "wandering" one, almost as if once a week the Demon of Chance drew a random number from a symmetrical population of fixed dispersion and added it to the current price to determine the next week's price. And this, we may recall, is not the behaviour in some small backwater market. The data derive from the Chicago wheat market over a period of fifty years during which at least two attempts were made to corner wheat, and one might have expected the wildest irregularities in the figures. To the statistician there is some pleasure in the thought that the symmetrical distribution reared its graceful head undisturbed amid the uproar of the Chicago wheat-pit. The economist, I suspect, or at any rate the trade cyclist, will look for statistical snags before he is convinced of the absence of systematic movements. And he will be very right to do so.

9. One possible source of error is that, in treating as homogeneous a price-series extending from 1883 to 1934, we may be oversimplifying the hypotheses. The series was therefore divided into two sections covering the periods 1883–1914 and 1921–1934; and a bivariate distribution of first differences on the lines of Table 1 constructed for each. I omit the figures to save space, but the story told by each section was the same as for the series taken together.

There are seven widely outlying values in the whole series, and it did not seem to me to be sophisticating the data to omit them from the calculation of moments.† The following constants were computed from a more finely grouped distribution and are corrected by Sheppard's formulae for the grouping effect.

	Period 1883–1914	*Period* 1921–1934	*Both Periods Together*
μ_1'	0	0·0964	0·0289
μ_2	7·7576	22·7789	12·3294
μ_3	12·6787	34·5882	20·2709
μ_4	657·3073	2745·8873	1293·0607
β_1	0·344	0·101	0·219
β_2	10·856	5·292	8·506

The distributions are accordingly rather leptokurtic.

10. The general pattern of independence present in these data makes it very unlikely that there are large serial correlations present but to make sure they were worked out to the tenth order and are given in Table 2. For computing purposes it is easier to work out serial covariance

* The weekly series are, so far as possible, closing quotations on Fridays and are given to the nearest $\frac{1}{8}$ cent. The monthly figures are averages of four or five weekly figures.

† Three values are due to a jump from September 21st to September 28th, 1888, of 53 cents and a recession the following week of 38 cents; four values are due to a similar movement in May, 1898.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 1

Frequency Distribution of Differences of Series 20, *Difference between Weeks* t *and* t + 1 *against Difference between Weeks* t + 1 *and* t + 2.

(Condensed to save space from original table for which the interval was one unit. Values falling on the border line of intervals were allotted ½ to each.)

Difference, t^{th} week less $(t+1)^{th}$ week; cents per bushel.	*Difference,* $(t+1)^{th}$ *Week Less* $(t+2)^{th}$ *Week; Cents per Bushel, Mid-point of Interval*																					
	−21	−19	−17	−15	−13	−11	−9	−7	−5	−3	−1	1	3	5	7	9	11	13	15	17	19	21	*Totals*
−17	—	—	—	—	—	—	—	—	—	—	½	—	—	—	—	—	—	—	—	—	—	—	½
−15	—	—	—	—	—	—	—	—	—	1	½	1	—	—	—	2¼	¼	—	—	—	—	—	5
−13	—	—	—	—	—	—	—	—	1	1	1	2	—	—	½	¾	¼	—	—	1	—	1	8½
−11	—	—	—	—	—	—	—	—	1½	—	½	½	2	1	—	—	1	1	—	—	—	—	7½
−9	—	—	—	1	—	—	—	2	2½	3	3½	4	2	3	2	—	—	—	1	—	—	—	24
−7	—	—	—	—	1	—	3	2½	3	4	10	8	5	2	6	1	—	1	—	—	1	—	47½
−5	—	—	—	1	1	1	5	5½	8½	9¼	23	28¾	16	8½	3½	1	2	—	—	—	—	—	114
−3	—	—	—	½	½	2	5	6½	16	28	64¼	91	27¼	12½	6½	—	1	—	—	1	—	1	263
−1	—	—	—	—	3	2½	4	12½	27½	86¾	232	236¾	78½	19	12½	1½	2	2	—	½	—	—	721
1	½	½	—	—	—	—	3½	10½	22	71	268½	207¼	82¼	29¾	6¼	3	1	—	1½	1	—	—	708½
3	—	—	—	—	—	—	1	5	13¾	30¾	82¼	89¼	47½	8¾	4¼	1½	½	—	—	—	—	—	284½
5	—	—	—	—	1	1	1½	3	7¾	16¼	18½	20½	11½	9	5	2	—	1	1	—	—	1	100
7	—	—	—	½	—	—	1	1	6	7½	11½	12½	6½	2½	—	1	—	—	—	—	—	—	50
9	—	—	—	½	1	—	—	1	2	2	1½	—	2½	1½	1½	2½	—	—	—	—	½	½	17
11	—	—	—	—	—	—	—	—	1	1	3½	—	½	1½	—	½	—	—	—	1	—	—	9
13	—	—	—	—	—	—	—	—	—	—	—	1	1	—	2	—	—	—	1	—	—	—	5
15	—	—	½	½	½	—	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	4½
17	—	—	—	—	½	—	—	—	1	—	—	3	—	—	—	—	—	—	—	—	—	—	4½
19	—	—	—	½	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1½
21	—	—	—	½	—	1	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	3½
Totals	½	½	½	5	8½	7½	24	49½	114½	262½	721	707½	283½	100	50	17	8	5	4½	4½	1½	3½	2,379

Note.—There were also seven outlying pairs with values (−6·75, −53·0), (−53·0, 37·75), (37·75, −1·25), (−6·5, −30·75), (−30·75, 3·75), (−20·0. 53·0) and (53·0, 11·75). The last term of the series was taken with the first so that the total number of pairs is 2,386.

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Serial Correlations of First Differences of Wheat Prices (Series 20)

(Decimal points omitted)

Order of Correlation	*Series* 1883–1914 (n = 1,669)	*Series* 1921–1934 (n = 716)	*Whole Series* 1883–1934 (*Omitting* 1915–1920) (n = 2,385)
1 . . .	−078	−063	−071
2 . . .	+078	+051	+065
3 . . .	−000	+030	+014
4 . . .	−075	+042	−019
5 . . .	+007	−066	−028
6 . . .	−032	−071	−051
7 . . .	−016	−039	−027
8 . . .	−059	−064	−061
9 . . .	−047	+023	−014
10 . . .	−038	+034	−004
Large sample standard error . . .	0·025	0·038	0·020

for the primary series and to calculate those of the differences from formulae such as

$$\sum_{i=1}^{n-2}(x_{i+2}-x_{i+1})(x_{i+1}-x_i) = 2\sum_{i=1}^{n-1}x_ix_{i+1} - \sum_{i=1}^{n}x_i^2 - \sum_{i=1}^{n-2}x_ix_{i+2} + x_1^2 + x_n^2 - x_1x_2 - x_{n-1}x_n \quad . \quad (1)$$

For long series when end effects can be neglected this is for all practical purposes equivalent to

$$\tau_k = -\tfrac{1}{2}\Delta^2\rho_{k-1}/(1-\rho_1) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where τ represents the autocorrelations of first differences and ρ those of the primary series. In this case it was not much extra trouble to take end-effects into account and the serial correlations for the constituent series in Table 2 were calculated from the formula

$$r_k = \frac{\sum_{i=1}^{n-k-1}u_iu_{i+k} - \frac{1}{n-k-1}\sum_{i=1}^{n-k-1}u_i\sum_{i=k+1}^{n}u_i}{\left[\left(\sum_{i=1}^{n-k-1}u_i^2 - \frac{1}{n-k-1}\left(\sum_{i=1}^{n-k-1}u_i\right)^2\right)\left(\sum_{i=k+1}^{n}u_i^2 - \frac{1}{n-k-1}\left(\sum_{i=k+1}^{n}u_i\right)^2\right)\right]^{\frac{1}{2}}} \quad . \quad (3)$$

where u_i is the difference $x_{i+1} - x_i$.

In calculating the serials for the two series together a weighted average was taken, the formula being

$$r_k = \frac{(n_1-k-1)c_1 + (n_2-k-1)c_2}{\{(n_1-k-1)v_{11} + (n_2-k-1)v_{21}\}^{\frac{1}{2}}\{(n_1-k-1)v_{12} + (n_2-k-1)v_{22}\}^{\frac{1}{2}}} \quad . \quad (4)$$

where n_1, n_2 are the number of terms, v_{11}, v_{21}, v_{12} and v_{22} refer to the variances of the first $n-k$ terms of the first and second series and the last $n-k$ terms of the first and second series respectively and c_1, c_2 are the covariances of the first and second series. Equation (4) has no very firm theoretical basis but it is obviously reasonable and will certainly not underestimate the magnitude of the serial correlations.

11. A comparison of the variances of the two parts of the series suggests that there has been an increase in variability since World War I. This is what one might perhaps have expected, but it is rather a nuisance from the point of view of analysis because it suggests that the series is not stationary. We have here an interesting and rather unusual case of a time-series for which the mean remains constant but the variance appears to be increasing. It is desirable to have a test of this type of departure from stationarity, distribution-free if possible. The problem is easy enough for a random series but not so easy for an autocorrelated series of unknown character, and as I do not require the test for present purposes I omit a discussion of the point.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

12. A glance at Table 2 shows that the serial correlations are very small and, for most practical purposes, negligible. However, the first two serials are, in four cases out of six, more than three times their standard error as calculated from R. L. Anderson's formula

$$\text{var } r_k = \frac{n-1}{(n-2)^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

There are several possible explanations of this effect. Anderson's formula is based on normality and constant variance in the series. From general experience one would not expect the sampling variance to be increased by departure from parent normality in the direction of leptokurtosis, the distribution being symmetrical and n large. Nor, as it seems to me, can we appeal to non-stationarity to account for the difference, because the discrepancies occur most markedly in the first part of the series. I proceed to consider two more practical possibilities, one that the primary series was rounded up (or down) systematically, the other that for hour-to-hour or day-to-day changes in price there were systematic variations which have been lost to view in the weekly figures.

13. Suppose that a series of values $x_1, \ldots x_n$ is systematically rounded up by amounts $\varepsilon_1, \ldots \varepsilon_n$, ε thus having a positive mean but being serially independent. We shall then have for the differences $u_i (= x_{i+1} + \varepsilon_{i+1} - x_i - \varepsilon_i)$, in long series

$$\text{corr } (u_i, u_{i+k}) = \frac{-\Delta^2 \rho_{k-1}}{2(1-\rho_1) + 2 \text{ var } \varepsilon/\text{var } x} \qquad k > 1$$

$$= \frac{-\Delta^2 \rho_{k-1} - \text{var } \varepsilon/\text{var } x}{2(1-\rho_1) + 2 \text{ var } \varepsilon/\text{var } x} \qquad k = 1 \quad . \quad . \quad . \quad (6)$$

In our present case var x is of the order of 10 and (the series being given to the nearest $\frac{1}{8}$th) var $\varepsilon = \frac{1}{12}\left(\frac{1}{8}\right)^2 = 0{\cdot}0^2 13$. The effect of factors in var ε/var x, of the order of $0{\cdot}0^3 1$, in (6) is therefore quite insufficient to account for the observed size of the first serial. In any case it would not account for the sign of the second. Even if we suppose that the rounding off was alternately up and down, which would induce autocorrelation in the ε's, the magnitude of the effect would not be large enough to explain the observations.

14. Consider then the attenuation in serial relationship which may be caused by averaging over time-periods. Suppose a market is open from Monday to Friday, that any Monday may be regarded as following immediately on the preceding Friday and that the scheme of generation from day to day is a simple Markoff process

$$u_{t+1} = \alpha u_t + \varepsilon_{t+1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

It is fairly easy to show that the correlation between the average of the five daily prices in one week and the corresponding average in the succeeding week is given by

$$r = \frac{5\alpha^5 + 4(\alpha^6 + \alpha^4) + 3(\alpha^7 + \alpha^3) + 2(\alpha^8 + \alpha^2) + (\alpha^9 + \alpha)}{5 + 8\alpha + 6\alpha^2 + 4\alpha^3 + 2\alpha^4} \quad . \quad . \quad (8)$$

For $\alpha = 0{\cdot}8$ $r = 0{\cdot}499$ and the correlation is reduced by 38 per cent. For $\alpha = 0{\cdot}5$ $r = 0{\cdot}178$ and the serial correlation between weekly averages is only a third of that between days. For $\alpha = 0{\cdot}1$ $r = {\cdot}02$. Evidently the averaging over successive terms may obliterate some quite substantial serial correlation in prices. The weekly wheat figures were not, in fact, averages over the days of the week, but it is evident that the choice of one day in the week as the representative point will stilll further attenuate any day-to-day correlations.

A simple Markoff process would still not account for the negative sign of r_1 in Table 3 unless the correlation between successive days was negative, which seems unlikely but is not impossible owing to the tendency of a sensitive market to swing too far and to correct itself. I ought perhaps to mention that the possibility of "significant" serials appearing owing to very occasional exceptional values was dismissed after examination of the series at such values.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

15. It may well be, then, that the observed serials, small as they are, have some significance. But evidently the systematic element is slight compared with the random component and a very precise technique is going to be necessary in order to extract it, unless we know what to look for.

Some of my colleagues have pointed out that the operation of first differences could easily reduce quite a large cyclical effect below the threshold of detectability. For example, if there were a ten-year cycle in the data, corresponding to about 500 terms of the series, the differencing of a sine wave of amplitude comparable in magnitude to that of the observed fluctuations would be to reduce the amplitude in the differenced series by a factor of about $2\pi/500$ but to double the variance of random effects. We cannot say, then, that the analysis has ruled out the existence of periodic terms. There may well be traces of a seasonal effect present. What we may fairly say, I think, is that we do not need to invoke them to explain the observations.

16. Series 21 is a derivative of Series 20, being a monthly average instead of a weekly one. A frequency distribution of first differences, which I omit to save space, tells much the same story as Series 20. For the moments I find, with Sheppard's corrections

	Whole Series	*Omitting One Extreme Value at Each End*
$\mu_1' =$	0·0776	0·0504
$\mu_2 =$	44·0256	34·8271
$\mu_3 =$	208·2139	6·4153
$\mu_4 =$	32,721·3887	6,914·5455

For the series on the right

$$\beta_1 = 0{\cdot}00151 \qquad \beta_2 = 5{\cdot}701$$

The distribution is nearer normality, as one might expect under the central limit effect. Some of the serial correlations are given in the reply to the discussion.

17. A comparison of the variances and fourth moments of Series 20 and 21 raises no reason to suspect their wandering nature. If $u_1, \ldots u_{4n}$ is a series of $4n$ weekly terms, the series of monthly terms is $\frac{1}{4}(u_1 + u_2 + u_3 + u_4)$, $\frac{1}{4}(u_5 + u_6 + u_7 + u_8)$, etc. For the differences of these typified by η, we have (means being approximately zero)

$$\text{var}\,\eta = \frac{1}{16(n-1)} \sum_{j=0}^{n-2} (u_{4j+1} + u_{4j+2} + u_{4j+3} + u_{4j+4} - u_{4j+5} - u_{4j+6} - u_{4j+7} - u_{4j+8})^2$$

or, for large n,

$$\text{var}\,\eta = \frac{1}{16n} \sum_{=0}^{n-2} \{(u_{4j+1} - u_{4j+2}) + 2(u_{4j+2} - u_{4j+3}) + 3(u_{4j+3} - u_{4j+4}) + 4(u_{4j+4} - u_{4j+5}) + 3(u_{4j+5} - u_{4j+6}) + 2(u_{4j+6} - u_{4j+7}) + (u_{4j+7} - u_{4j+8})\}^2.$$

If the differences of u, typified by ε, are independent we then have

$$\text{var}\,\eta = \frac{1}{16}\,\text{var}\,\varepsilon\{1^2 + 2^2 + 3^2 + 4^2 + 3^2 + 2^2 + 1^2\}$$

$$= \frac{11}{4}\,\text{var}\,\varepsilon \qquad (9)$$

The ratio of variances of the monthly to the weekly series is $34{\cdot}8271/12{\cdot}3294 = 2{\cdot}82$ against the theoretical value of $2{\cdot}75$. It may be shown similarly that $\kappa(\eta) = 113/64\,\kappa(\varepsilon)$. For the whole series the ratio $\kappa_4(\eta)/\kappa_4(\varepsilon)$ is $3{\cdot}12$ and for the series omitting extreme values $2{\cdot}12$ against the theoretical value $1{\cdot}77$.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

18. There seems nothing to be gained by taking averages of the monthly figures to obtain an annual figure. Under the central limit effect the resulting series would be nearly normal; and successive values would almost certainly be nearly independent.

19. In the past I have often wondered whether annual figures were much use in the study of economic phenomena, except of course in relation to intermittent variables like crop-yields. So much can happen in a year that one feels the underlying causational system to require examination under a finer structure than an annual interval. But if this wheat-series is any guide, it seems that what we gain by observing the phenomenon at short intervals is lost, or at any rate deeply obscured, by the stochastic discontinuity of the process. It may be that the motion is genuinely random and that what looks like a purposive movement over a long period is merely a kind of economic Brownian motion. But economists—and I cannot help sympathizing with them—will doubtless resist any such conclusion very strongly. We can at this point suggest only a few conclusions:

(*a*) the interval of observation may be very important;
(*b*) it seems a waste of time to try to isolate a trend in data such as these;
(*c*) prediction in such a series, from internal behaviour alone, is subject to a wide margin of error and the best estimate of the change in price between now and next week is that there is no change.

British Industrial Share Prices (*Series* 1–19)

20. Series 1 to 19 are weekly index numbers based on 1930 = 100. (The price taken is that of Tuesday of each week, not an average of the week's quotations.) They are not all independently compiled, series 11 (Total industrial production) being an average of series 12–14, series 18 (Total industrial miscellaneous) being an average of series 16 and 17, and series 19 being an average of all classes. There are thus 15 independent series. During the period covered by the figures there were, I believe, some changes such as substitutions for quotations which dropped out. But this hardly affects my argument. Taken together, these are as complete and reliable a set of figures describing the inter-war movement of the U.K. industrial share market as one is likely to find.

21. The first 29 serial correlations were computed for each series and are given in Table 3. The method used was similar to that for series 20 except that corrections for means were omitted as being negligible and the variance of the whole series used in the denominator, the formula accordingly being

$$r_k = \frac{\frac{1}{n-k}\sum_{i=1}^{n-k} u_i u_{i+k}}{\frac{1}{n}\sum_{i=1}^{n} u_i^2} \qquad (10)$$

It may be shown that for these series this approximation can affect the third decimal place at the most, except perhaps for series 3. To resolve any doubt the serials were worked out exactly for this series and the exact values were found to differ from the approximate ones only in the fourth decimal place.

For some of the series a bivariate distribution on the lines of Table 1 was constructed. In some cases the general picture of independence was presented, but in others there were signs of dependence as reflected in the serial correlations. I have space to reproduce only one, that for Series 3, where the dependence seems to be the highest (Table 4).

22. Such serial correlation as is present in these series is so weak as to dispose at once of any possibility of being able to use them for prediction. The Stock Exchange, it would appear, has a memory lasting less than a week except perhaps for Investment Trusts (Series 3), Stores and Catering (Series 14) and all series together. It may be, of course, that series of *individual* share prices would behave differently; the point remains open for inquiry. But the aggregates are very slightly correlated and some of them are virtually wandering. Investors can, perhaps, make money on the Stock Exchange, but not, apparently by watching price-moments and coming in on what looks like a good thing. Such success as investors have seems to be due (*a*) to chance,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Serial Correlations of Series 1–19, Lag 1 to 29

(Decimal points omitted)

Lag	*Number of Series (see Para. 4)*									
	1	2	3	4	5	6	7	8	9	10
1	058	052	301	125	148	087	181	096	088	−013
2	061	−016	356	−001	075	121	055	185	−055	045
3	014	082	158	−025	061	061	053	049	011	−024
4	−050	−019	164	−079	−056	015	−016	086	043	−022
5	−087	−082	066	−025	−055	−030	−084	−005	−015	044
6	−028	−093	−101	−034	−056	−125	−085	−022	−091	−034
7	−015	−006	−030	001	−054	−044	−092	−036	−076	−029
8	−011	−042	−042	−013	−001	−058	−055	001	−020	004
9	004	−025	−030	−041	−084	−118	−067	056	−022	005
10	015	008	−033	010	−063	−067	−012	027	−015	−044
11	045	−050	−013	−022	042	−037	064	025	007	052
12	002	000	−094	048	040	004	000	043	046	004
13	−014	037	−052	045	021	048	040	049	094	009
14	−017	004	009	008	−037	−056	081	067	−060	−025
15	−062	032	027	050	−006	062	047	046	−039	−019
16	030	006	008	118	076	015	039	049	069	002
17	072	079	109	030	068	153	041	119	076	043
18	097	049	086	045	030	070	018	028	−028	036
19	098	−016	080	−016	031	−017	−009	−055	−036	−015
20	−037	−077	020	−026	−046	072	−023	016	−033	037
21	009	060	031	074	−031	−078	−056	052	004	−021
22	−027	011	−056	044	−067	−094	−029	074	−023	076
23	−044	−151	−047	056	−004	−084	−029	−041	−091	−048
24	034	−005	−086	−023	−020	−017	−001	043	−049	017
25	104	017	031	069	−039	015	016	133	076	−009
26	021	080	−048	038	−001	−012	029	067	044	−032
27	000	004	011	−017	082	−046	094	044	032	−052
28	045	130	053	071	097	−011	036	036	040	087
29	−011	−040	050	−014	060	−014	033	037	061	031

Lag	*Number of Series*								
	11	12	13	14	15	16	17	18	19
1	195	010	053	230	237	034	200	177	234
2	061	−057	029	054	076	087	103	106	105
3	053	044	−044	018	054	003	053	058	066
4	−034	039	−014	001	−040	−056	−013	−044	−046
5	−051	−015	−034	−084	−062	067	−080	−044	−055
6	−102	−081	058	−146	−093	−002	−115	−079	−094
7	−072	018	−013	−144	−072	019	−104	−087	−093
8	−043	139	036	−057	−044	−114	004	−033	−041
9	−047	033	037	−038	165	−018	−003	−003	−008
10	−047	−044	021	042	021	035	012	−091	−023
11	−003	079	046	−006	013	085	−014	013	005
12	039	069	044	086	089	017	024	142	050
13	082	−009	−009	−047	−006	077	037	064	045
14	−029	−041	−107	004	−008	−036	−037	−029	−025
15	036	−129	096	067	018	−084	045	001	033
16	069	030	090	064	077	055	158	122	114
17	145	005	168	029	086	001	124	120	148
18	047	072	063	047	082	029	089	079	084
19	−010	013	042	−001	057	047	010	022	038
20	007	005	008	035	014	−078	−001	−045	−017
21	−018	−012	−030	090	043	041	009	031	008
22	−035	009	−027	032	013	064	−015	033	−006
23	−082	−056	022	−039	−082	−005	−053	−045	−070
24	−041	−032	−037	−034	−021	028	−008	−008	−028
25	051	036	−000	002	−001	058	−001	017	026
26	025	037	086	−038	−005	046	036	049	036
27	047	055	092	−032	052	−019	030	012	038
28	168	048	016	−037	007	023	072	063	075
29	−069	039	−054	−004	032	−014	018	001	014

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Bivariate Distribution of First Differences of Series 3, *Difference between Weeks* t *and* t + 1 *against Difference between Weeks* t + 1 *and* t + 2; *Units, One-tenth of a Point*

Difference, t^{th} week, less $(t+1)^{th}$ week	*Difference* t + 1th *Week Less* t + 2th *Week*														
	< −12	−12, −11	−10, −9	−8, −7	−6, −5	−4, −3	−2, −1	0, 1	2, 3	4, 5	6, 7	8, 9	10, 11	⩾ 12	*Totals*
< −12	5	2	4	5	1	2	—	—	1	—	—	—	—	1	21
−12, −11	4	1	1	—	3	1	3	—	—	—	—	—	—	—	13
−10, −9	1	2	2	—	2	2	4	—	—	1	—	1	—	—	15
−8, −7	3	2	—	4	4	5	4	—	1	—	1	—	—	1	25
−6, −5	4	3	2	4	7	11	9	3	1	1	—	—	—	1	46
−4, −3	1	2	2	6	7	17	13	14	2	—	1	1	—	—	66
−2, −1	1	1	1	2	9	19	14	18	5	5	2	2	1	1	81
0, 1	—	—	—	1	6	8	22	26	13	9	3	2	1	—	91
2, 3	—	—	2	1	1	—	5	15	9	4	3	3	—	1	44
4, 5	1	—	—	1	3	—	3	7	7	5	1	1	2	1	32
6, 7	—	—	—	—	2	1	—	3	1	2	—	2	1	2	14
8, 9	—	—	1	—	1	—	1	2	1	3	2	—	—	4	15
10, 11	—	—	—	—	—	—	1	2	2	1	—	1	—	1	8
⩾ 12	—	—	—	—	—	—	1	1	1	1	—	2	3	1	14
Totals	21	13	15	25	46	66	81	91	44	32	14	15	8	14	485

(*b*) to the fact that at certain times all prices rise together so that they can't go wrong, (*c*) to having inside information so that they can anticipate a movement, (*d*) to their being able to act very quickly, (*e*) to their being able to operate on such a scale that profits are not expended in brokers' fees and stamp duties. But it is unlikely that anything I say or demonstrate will destroy the illusion that the outside investor can make money by playing the markets, so let us leave him to his own devices.

23. There are several factors of these series of correlations requiring explanation.

(*a*) If we arrange them according to the magnitude of the first serial correlation, which seems a fair summary measure of internal correlation, we get the following order:

Series 3	Investment Trusts.
15	Total Distribution.
19	All classes.
14	Stores, etc.
17	Miscellaneous.
11	Total Production.
7	Electric Light.
18	Total Miscellaneous.
5	Coal.
4	Building Materials.
8	Gas.
9	Iron and Steel.
6	Cotton.
1	Banks.
13	Shipping.
2	Insurance.
16	Breweries.
12	Home rails.
10	Oil.

We can understand why this list should be headed by investment trusts, which are almost an aggregative index in themselves, and why it should be tailed by shipping, breweries, home-rails and oil. But it is not clear why banks and insurance companies come so low.

(*b*) Apart from investment trusts and stores, the series showing the greatest internal correlations are the aggregative series 11, 15, 18 and 19. We get greater serial correlation in the averages than in the constituent series, which at first sight seems absurd and in any case is very misleading. One possibility is that this effect is generated by the method of construction of the series, e.g., the use of geometric means, the substitution of new quotations and so on. With the help of Mr.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

S. T. David and Mr. Haycocks I went into this explanation fairly thoroughly but it does not seem to account for the phenomenon. The use of geometric means could raise or lower the serial correlations but need not bias them upwards; substitution of new quotations is carried out only in December and its effect, even if systematic, would be so diluted in the correlation of weekly figures as not to explain the magnitude of the aggregation effects. A more likely explanation lay in the existence of lag correlations between the series and I revert to the point below in paragraph 28.

24. Whatever the reason, the existence of these serial correlations in averaged series is rather disturbing. If the effect is a general one, it means that we must be very chary of drawing inferences from series of index numbers of the aggregative type, which is most unfortunate because such series are, in many instances, all that the statistician or the economist has to work on. The so-called "cycles" appearing in such series may not be due to endogenous elements or structural features at all, but to the correlations between disturbances acting on the constituent parts of the aggregative series.

25. I am led to infer that wherever possible the econometrician must study individual series rather than aggregates, just as he must study closely neighbouring points of time rather than observations at long intervals. This may be part of the reason why attempts to fit simple models to a whole economy have usually failed. It is as though a physicist set out to investigate the properties of light without being able to isolate a pure colour and with a diffraction grating ruled at intervals of an inch apart. Such conclusions would apply to price data, or to any nundinal data where there is a rapid adjustment of forces in a fluid market. They may not apply with equal force to production data.

Cross-correlation of the Share-prices

26. To study the series further we have to examine the correlations between them. It is possible to pick out pairs from 19 individuals in 171 ways and even with modern computing facilities it was too laborious to work out a number of lag correlations for them all. I chose 28 pairs, taking those for which the analysis seemed likely to be most rewarding. It was as follows:

(1, 4), (1, 5), (1, 6), (1, 9), (1, 12), (1, 13)
(4, 5), (4, 6), (4, 8), (4, 12), (4, 13)
(5, 6), (5, 8), (5, 9), (5, 12)
(6, 8), (6, 9), (6, 11), (6, 12)
(8, 11), (8, 18)
(9, 11), (9, 12), (9, 13)
(11, 12), (11, 13), (11, 18)
(12, 13)

110634

The numbers correspond to the series set out in section 4. The lags even worked out as far as the sixth each way, e.g., (1, 4) means that lag correlations were worked out between first differences of series 1 and 4 (Banks, etc., and Building Materials) for lags of -6 to 6, thirteen coefficients in all. The results are given in Table 5.

27. The main feature of this set of correlations is the smallness of the magnitudes for the lags. There are traces of correlation in some instances but, however real, they are very slight. Thus no series acts as a "leader" for the others. Not only is it impossible to predict a series from its own internal behaviour but it seems equally impossible to predict it from the behaviour of the other price series.

28. We can now revert to the aggregation effect mentioned in paragraph 23 and discuss it in simplified terms. Suppose we have a series of consecutive pairs of terms $(\varepsilon_1, \eta_1)(\varepsilon_2, \eta_2) \ \ldots$ (ε_n, η_n) with zero means. Consider the correlation of sums $E \equiv \sum_{i=1}^{n} \varepsilon_i$ and $F \equiv \sum_{i=1}^{n} \eta_i$. If the variance of ε_i and η_i is σ_i^2 we find

$$\text{corr}\,(E, F) = \frac{\sum_{i,j} \sigma_i \sigma_j \,\text{corr}\,(\varepsilon_i \eta_j)}{\sum \sigma_i \sigma_j \,\text{corr}\,(\varepsilon_i, \varepsilon_j)} \qquad i, j = 1 \ \ldots \ n \quad . \quad . \quad . \quad (11)$$

519.905
J82J 116
A25A

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 5

Lag Correlations of the Differences of Certain Pairs of Series from Series 1–19

	Lag												
Series	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6
(1, 4)	−008	−066	−077	−021	036	028	414	100	015	008	023	−080	−125
(1, 5)	−060	−134	−137	−068	015	030	255	077	102	−011	015	011	−066
(1, 6)	−080	−037	−074	−087	019	029	228	126	163	010	062	−010	−118
(1, 9)	−023	−102	−139	−014	−027	−021	295	053	050	028	−020	027	−028
(1, 12)	−037	−023	−046	−029	017	−044	275	154	073	0003	−001	022	−118
(1, 13)	−033	−068	−060	−124	113	051	258	121	030	−015	004	−063	−070
(4, 5)	−064	−108	−102	002	034	070	425	200	035	052	−044	−019	016
(4, 6)	−059	−036	−047	−003	059	058	424	201	076	054	−027	−003	−089
(4, 8)	−037	−067	−015	−024	049	085	310	−002	023	030	006	−027	−046
(4, 12)	022	−071	−049	026	−009	−006	367	187	−006	059	031	018	−066
(4, 13)	048	−052	−033	054	046	111	320	096	019	002	−068	001	010
(5, 6)	−080	009	051	083	048	182	454	161	081	054	−043	−108	−134
(5, 8)	−013	−013	026	00001	044	009	272	004	025	035	−056	−042	007
(5, 9)	−075	−016	−065	070	013	096	661	226	033	024	015	−065	−053
(5, 12)	026	−014	−036	074	037	063	392	167	024	−013	025	−048	−072
(6, 8)	−040	−033	037	−004	064	024	194	014	−031	012	−003	032	−072
(6, 9)	−122	083	004	078	038	085	482	228	030	013	071	024	−115
(6, 11)	−127	−073	004	092	104	156	750	140	080	033	018	011	−124
(6, 12)	−095	−034	−031	110	014	089	368	194	−027	011	−024	033	−114
(8, 11)	−020	−049	−027	069	002	006	389	066	075	−002	023	−046	−030
(8, 18)	−033	−064	−032	055	−005	−046	399	079	125	002	010	−051	−028
(9, 11)	−087	−004	042	022	022	228	795	071	−032	033	−038	−060	−101
(9, 12)	−056	−025	041	039	008	016	469	110	−070	060	042	−048	−149
(9, 13)	007	−031	026	133	092	144	279	102	−037	047	−111	−029	−002
(11, 12)	−053	−035	−060	072	010	054	522	224	−024	059	036	−004	−120
(11, 13)	066	−076	038	082	042	199	407	140	041	011	−056	−067	021
(11, 18)	−051	−004	007	036	094	196	824	166	069	065	−108	−084	−101
(12, 13)	−039	−022	044	041	039	146	281	045	031	001	−085	−008	−031

Note.—Decimal points omitted. Lag counted as interval of first series after second, e.g., lag 2 for series (1, 4) is correlation of series 1 at time $t + 2$ and series 4 at time t.

or, if all the variances are equal,

$$\text{corr}\,(E, F) = \frac{\text{mean corr}\,(\varepsilon_i, \eta_j)}{\text{mean corr}\,(\varepsilon_i, \varepsilon_j)} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

For my series I do not possess all the lag correlations but as an example of the kind of thing which may happen let us suppose that all the correlations $(\varepsilon_i, \varepsilon_j)$ have a mean value of 0·4 (this being about the mean of those values we have in Table 5) and that the mean correlation of (ε_i, η_j) is 0·1. Then we find

$$\text{corr}\,(E, F) = \frac{225\,(0{\cdot}1)}{15 + 210\,(0{\cdot}4)} = 0{\cdot}23$$

so that the first serial of the aggregate series is more than twice the mean serials of its constituents. It is a piece of good luck, I suppose, that the first serial of series 19 turns out to be 0·234.

29. The cross correlations of order zero suggest that there is a good deal of *simultaneous* sympathetic movement between the series; (simultaneous, that is, within the compass of a single week). They are more or less as one would expect but not always so big as a simple model of the economy would suggest. If we regard these random changes from week to week as due to exogenous elements, we must suppose that the elements are substantially different from one series to another, albeit not independent.

30. One could clearly take this analysis further, for instance by working out multiple regressions or attempting a component analysis to see whether there were any common factors. I have refrained from doing so at this stage for two reasons; one is that further experiments on other

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

price series and for different intervals of time are desirable before we refine the analysis; the other is that the existence of the aggregative effect would probably vitiate the findings and I think we shall have to go back to primary series before attempting to isolate components.

New York Cotton Prices

31. The New York spot cotton prices of series 22 are a salutary warning against undue generalization. They are monthly, not weekly, series and cover about 125 years. One might have expected them to behave like the wheat series, but they do not. Table 6 gives the serial correlations up to the sixteenth order. As there were obvious breaks in continuity during the

TABLE 6

Serial Correlations of Cotton Prices (Series 22)

(Decimal points omitted)

Order of Correlation	*Period* 1816–1860	*Period* 1868–1914	*Period* 1921–1950	*Total Series* (1816–1950)
1	346	393	227	313
2	096	046	−012	039
3	−049	−096	−027	−053
4	−045	−153	−172	−125
5	−075	−060	024	−032
6	−053	−075	095	−000
7	−013	−068	031	−010
8	015	−064	135	041
9	−037	−028	021	−012
10	001	071	122	068
11	029	088	−000	033
12	−051	080	−106	−038
13	−093	−006	024	−014
14	−143	032	047	012
15	−105	−011	025	016
16	−022	−050	042	008

American Civil War and during World War I, I have calculated the serials separately for the periods 1816–1860, 1868–1914 and 1921–1950.

The bivariate distributions of the type of Table 1 are regular, looking very much like a normal form, but the correlations are significant. We now find a pattern of behaviour rather like that of a simple Markoff series. The price-change from month t to month $t+1$ is now clearly correlated with that from month $t+1$ to month $t+2$, but we do not require a memory of more than a month in the market to account for the serial correlation.

There are several possible explanations of this effect, although it is difficult to be sure whether any of them is the right one. Wheat is a commodity which is grown in both hemispheres and a continual supply on the market may keep the price more fluid than for cotton, a product of the northern hemisphere only. Moreover, crop forecasts are better for wheat than for cotton and there is a tendency for the latter to be underestimated at the beginning of the season; the slow improvement in estimates as the growing season proceeds might induce some correlation in the prices. The slower rate of progress of cotton through the manufacturing process may also have some effect. But whatever the reason, it seems that we are not entitled to generalize from one agricultural commodity to another and a systematic survey of the major raw materials of commerce is necessary before we can lay down any general rules.

First Experiments in Trend Fitting

32. The typical Yule autoregressive scheme which has been fitted to economic data with a certain amount of success may be written

$$\alpha u_{t+2} + \beta u_{t+1} + \gamma u_t = \varepsilon_{t+2} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It seems natural to generalize this by considering the case when the constants α are themselves slowly moving through time as the economy changes. I therefore examined the scheme

$$(\alpha_0 + \alpha_1 t + \alpha_2 t^2)\, u_{t+2} + (\beta_0 + \beta_1 t + \beta_2 t^2)\, u_{t+1} + (\gamma_0 + \gamma_1 + \gamma_2 t^2)\, u_t = \varepsilon_{t+2} \quad . \quad (14)$$

A second-order Yule scheme was chosen because general experience so far has indicated that nothing much is to be gained by taking higher orders into account; and second-degree polynomials were chosen because the general run of the series suggested that they would be sufficient and would keep the arithmetic within reasonable bounds. But a decision on these points is rather arbitrary and more extended schemes might be necessary in some cases. The fitting was carried out on the primary series not on the differences.

33. In equation (14), it will be noted, I have allowed the coefficient of u_{t+2} to vary with time. It would be more consonant with the idea of auto*regression* to take the coefficient as a constant, say unity. However, the more general expression has one advantage, namely that it allows for movements in the variance of the disturbance term ε, which may well vary in time, especially for price data. If the coefficients are small compared with the maximum observed value of t^2 equation (14) may be written

$$u_{t+2} + (\beta_0' + \beta_1' t + \beta_2' t^2)\, u_{t+1} + (\gamma_0' + \gamma_1' + \gamma_2' t^2) = (\delta_0 + \delta_1 + \delta_2 t^2)\, \varepsilon_{t+2} \quad . \quad (15)$$

which exhibits the scheme as an approximation to a generalized Yule process with trend in the variance of the disturbance.

34. It will also be noticed that (14) is not a stationary process. There is no reason why it should be. No economic system yet observed has been stationary over long periods. It is true that schemes of type (14) may be explosive, which all economic systems are not; but that only implies that in representing the slow movements by polynomials we are approximating to some non-explosive function, a familiar procedure to which no exception is taken in other fields of application.

35. I fitted a scheme of type (14) by least squares, that is to say, by minimising the square of the expression on the left for variations in the nine parameters. This leads to nine equations with coefficients of the type $\Sigma t^2 u^2_{t+2}$, $\Sigma t\, u_{t+1} u_{t+2}$, etc. They are troublesome to compute but there is no theoretical difficulty. For the experiment series 1, 6 and 8 (Banks, etc., Cotton and Gas) were taken. The following are the results. The origin in each case is at the 244th term so that t ranges from -243 to 242.

Series 1

$$(1 + 0{\cdot}021{,}279{,}208t - 0{\cdot}0^4 31{,}214t^2)\, u_{t+2} + (-1{\cdot}236{,}892{,}571 - 0{\cdot}0^2 2{,}127{,}249t + 0{\cdot}0^4 40{,}297t^2)\, u_{t+1} + (0{\cdot}236{,}578{,}860 + 0{\cdot}0^3 848{,}707t - 0{\cdot}0^5 9{,}021t^2)\, u_t = \varepsilon_{t+2} \quad . \quad (16)$$

Series 6

$$(1 - 0{\cdot}0^2 3{,}435{,}032t + 0{\cdot}0^3 135{,}958t^2)\, u_{t+2} + (-0{\cdot}086{,}729{,}101 - 0{\cdot}0^4 95{,}266t - 0{\cdot}0^4 54{,}730t^2)\, u_{t+1} + (-0{\cdot}921{,}767{,}317 + 0{\cdot}0^2 3{,}562{,}777t - 0{\cdot}0^4 81{,}816t^2) = \varepsilon_{t+2} \quad . \quad (17)$$

Series 8

$$(1 + 0{\cdot}0^2 1{,}273{,}056t - 0{\cdot}0^4 37{,}456t^2)\, u_{t+2} + (-1{\cdot}421{,}129{,}272 - 0{\cdot}0^2 2{,}055{,}170t + 0{\cdot}0^4 56{,}754t^2)\, u_{t+1} + (0{\cdot}422{,}070{,}596 + 0{\cdot}0^3 822{,}663t - 0{\cdot}0^4 19{,}549)\, u_t = \varepsilon_{t+2} \quad . \quad (18)$$

36. These equations were worked out before it had dawned on me that the parent series were behaving in a wandering way, and at that stage it was a surprise when Mr. K. H. Medin, working in my department, pointed out that there were identities in the coefficients. In fact, very approximately

$$\left.\begin{aligned} \alpha_0 + \beta_0 + \gamma_0 &= 0 \\ \alpha_1 + \beta_1 + \gamma_1 &= 0 \\ \alpha_2 + \beta_2 + \gamma_2 &= 0 \end{aligned}\right\} \quad . \quad (19)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

For instance in (16)

$$1 - 1{\cdot}236{,}892{,}571 + 0{\cdot}236{,}578{,}860 = 0{\cdot}0^{3}313{,}911$$

and in (18)

$$-0{\cdot}0^{4}137{,}456 + 0{\cdot}0^{4}156{,}754 - 0{\cdot}0^{4}19{,}549 = -0{\cdot}0^{6}251$$

It follows, of course, that we can write (12) as

$$(\alpha_0 + \alpha_1 t + \alpha_2 t^2)(u_{t+2} - u_{t+1}) - (\gamma_0 + \gamma_1 t + \gamma_2 t^2)(u_{t+1} - u_t) = \varepsilon_{t+2} \quad . \quad . \quad (20)$$

so that first differences obey a generalized Markoff scheme. The ratio

$$(\gamma_0 + \gamma_1 t + \gamma_2 t^2)/(\alpha_0 + \alpha_1 t + \alpha_2 t^2)$$

varies to some extent over the range of t; for Series 1 from about 0·3 at one extreme to 0·2 at the other, being about 0·2 over the middle range; for Series 6 from about − 0·7 to − 0·5, about minus unity over the middle range; for Series 8 about 0·4 over the middle range.

On the whole I regard this experiment as a failure. It seems asking too much of quadratic polynomials to expect them to give a good representation over series of 500 terms; and in any case it is doubtful whether the series are sufficiently systematic to react significantly to this kind of treatment. The only reason I refer to the trend-fitting problem at all at this stage is to call attention to its difficulty in the hope that others may be led to study it.

37. I am well aware that this paper raises more difficulties than it resolves. Most papers on time-series do. The results concerning the time-interval of observation, the aggregative-effects and trend-fitting seemed to me, however, to be important enough to justify publication, if only to prevent my fellow-workers from spending time on profitless inquiries. More positive results must await further exploration of individual series, not only of prices but of production, and attempts to improve available statistical techniques for analysing them.

Acknowledgments

38. The computations involved have been severe, particularly in connection with the lag correlations of series 1 to 19. I am indebted to Mrs. Joan Humphries and Miss Julia Grahame for a great deal of the work, which they carried out with zeal and gratifying cheerfulness. I am also indebted to Mr. E. C. Fieller and the National Physical Laboratory for allowing me to use the electronic A.C.E. in determining serial covariances. My colleagues in the Division of Research Techniques at the London School of Economics, particularly Mr. S. T. David and Mr. K. H. Medin, have been very helpful in exploring lines of inquiry, many of which are referred to only very briefly or are not mentioned at all, that had to be followed up to decide incidental points; and my colleagues among the economists have endured much in discussions about the econometric implications of the results.

Discussion on Professor Kendall's Paper

Professor R. G. D. Allen: In moving this vote of thanks to Professor Kendall I should like to express the indebtedness of the Society not only to him but also to the Division of Research Techniques at the London School of Economics of which he is the Director. The Division, only a few years old, has been generously supported by the Nuffield Foundation. The publications of the Division are numerous, massive, and indicative of a long life for the Division. The work has not been at all concentrated; it has ranged over a surprisingly wide field. Some of the work on survey techniques has already been presented to this Society. Other work has been in the econometric field, as represented by the paper Professor Kendall has read tonight. This contribution is a generally understandable one. Not all econometric work is as intelligible to the layman or even to the expert. I hope that all economists as well as statisticians will read the paper and study it.

I want to take the point of view of the economist, not the statistician, who approaches the problem of handling time-series rather hopefully and at the same time apprehensively. Economists have learned much on this subject during the two decades or more since Yule's famous paper was read to the Society. They have come to look upon time-series with considerable suspicion. They have been told to beware of a fearsome devil—serial correlation—and to look to statisticians to

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

cast the devil out for them. It seems now that the more statisticians work on the casting out of devils, the more they cast out everything else, including what the economists want.

If the economist is to design a model to relate to actual data, he must deal in averages and aggregates, e.g., such broad aggregates as national consumption, income, savings, investment. Moreover, the testing of models in the past has usually been in the terms of annual data. The question is how to break up aggregates and how to shorten the intervals of recording in the time-series. Short annual series of data are usually not good enough to test any model whatever, and what Professor Kendall now appears to show is that, with more frequent data, many different models fit the data very well. This is a serious dilemma.

In para. 19 of the paper which indicates Professor Kendall's conclusion on wheat prices he points out that what we gain by observing the phenomena at short intervals is lost or obscured by "the stochastic discontinuity of the process", that it may be that the motion is genuinely random, and that what looks like a purposive movement over a long period is "merely a kind of economic Brownian motion". That is a very depressing kind of conclusion to the economist. The conclusions on cotton prices (para. 31) are rather more encouraging, a "memory" of a month. Even so, this may arise because of defects in the cotton market as opposed to the wheat market. Cotton is practically confined to the northern hemisphere and the making of crop estimates is a rather peculiar process. Finally, on stock prices, apart from the question of how to "play the market", we would expect to have dependable aggregate series of prices of all stocks together. Paragraphs 24 and 25, however, indicate that the problem is not a simple one.

In the present state of knowledge the economist must work with simple models relating to broad aggregates. If he ventures further the variables and relations—and the problems—crowd in on him. Professor Kendall's conclusion is that any attempt to fit simple models to data must inevitably fail. The econometrician is far from attaining the position in which he can hope to determine the parameters in which he is interested. This paper must be regarded as the first dividend on a notable enterprise. Some "shareholders" may feel disappointed that the dividend is not larger than it is, but we hope to hear more from Professor Kendall and to have further, and larger, declarations of dividends.

Professor CHAMPERNOWNE (in seconding the vote of thanks): Professor Kendall is a pioneer in the study of time series by examining serial correlation coefficients, and a paper from such an authority gives us hope for further revolutionary advances. Every hint that old techniques are faulty and every suggestion of new methods of analysis will eagerly be followed by those who have time and resources to experiment with new ideas. Therefore the more conservative amongst us, especially amongst the economists, may be excused if we endeavour to pick holes in the argument before it is allowed to become gospel. As seconder of the vote of thanks I feel an obligation in this respect, and shall devote my attention almost entirely to the points on which I disagree.

Turning, however, to the list of conclusions given in para. 3, I do not find that I disagree violently with anything except perhaps the last sentence of (*d*), that the more systematic behaviour of aggregative index numbers may be due to chance, and that if so there will appear spurious time-correlations in aggregative series, and the use of index numbers in econometric work will need extensive reconsideration. I hope that those responsible for using or criticizing or constructing index numbers will not be led by these conclusions to suppose that there is something wrong about index numbers, and that they should use individual quotations or do something more drastic instead. Unless I misunderstand Professor Kendall's arguments, he is drawing a red herring across any discussion of the merits of index numbers for the purposes for which they are usually intended.

He has shown that if in a set of price-series the intercorrelations lagged by one time-unit are nearly all positive, and if the unlagged correlations are not large, then the serial correlation coefficient with unit lag for the index number may be much larger than for any individual series. If the phenomenon is due to a cancelling-out of random elements he and all of us would agree that this merely shows that the index number expresses the systematic part of the price-movements better than any individual series. But Professor Kendall suggests that the effect may be entirely spurious and due merely to chance. This is possible, but it seems to me that pure chance alone will only on very rare occasions lead to the intercorrelations of lag 1, nearly all having positive sign and an average nearly as high as that of 0·1 found in Table 5. This does not look like chance; it indicates that there is a tendency towards a positive correlation between one term in one series and the following term in another. If so, the higher serial correlation of the index number reflects its advantageous quality and is not spurious.

With reference to conclusion (*e*), I may perhaps be excused for agreeing with the moral drawn there. The professionals have to keep a sharp eye on the movement of prices, on the one hand stifling large shifts of price that are likely to be immediately reversed, and on the other anticipating any movements of prices that would otherwise continue over a period of weeks; and the low serial

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

correlation coefficients found in this particular series may reflect the success with which the professionals are doing their job. It is reassuring that statisticians will not be able to earn vast sums by scientific gambling on the Stock Exchange, and will still find it worth while to continue their own work. I cannot resist saying that the analysis of prices of less speculative markets will have even greater interest for the economist.

Turning to conclusion (*c*), again it is difficult to disagree. It may be impossible to distinguish between different hypotheses which all fit the data, and the choice of possible hypotheses by prior analysis is, in the present state of knowledge, as essential as the testing and comparing of hypotheses by statistical methods. But there is a danger that people reading this conclusion will think that because Professor Kendall finds certain speculative price series have correlograms like those of wandering series, *ergo* it is futile to compare the trend, of say, real wages with the trend of other variables which, according to economic theory, determine real wages in the long run. Leaving aside the question whether seasonal and cyclical variations of prices have any precise meaning, there can be little doubt that the graphs of many price series exhibit such movements. If one is merely analysing the series by taking weekly changes in such prices and drawing up tables like Table 3 of the paper, I doubt whether the results would be so different from those of that table, my doubt being based on Professor Kendall's own admirable argument in the second part of para. 15, where he says that one does not need to invoke seasonal or cyclical changes to explain the observations. The danger is that this might be interpreted by some as meaning that cyclical and seasonal influences are not an important part of the movement of many economic time series. The fact that the correlograms of many economic series are like those of wandering series need not disturb us. If this effect is widespread it should give greater confidence in applying regression analysis to first differences of series. For example, even if the wholesale price and the retail price of a commodity, each regarded separately, behave in a manner indistinguishable from the wandering series, it might still be demonstrated that the relation between the two could not be best explained on the basis of chance. Here again I wish to defend Professor Kendall from those who might possibly misinterpret his own conclusions.

I fear that, after all, in what I have said I have failed to attack and have merely rushed in to defend the author against his more enthusiastic admirers, who may overstate some of his more spectacular claims and suggest that we should all study the correlograms of individual time series instead of the equations connecting them. This cannot be Professor Kendall's intention: indeed he has foreshadowed a further paper on the relations between price series and production series, to which we shall look forward with keen interest.

Mr. QUENOUILLE: Professor Kendall's paper is, as other speakers have indicated, a provocative one. Professor Kendall has dealt with such a wide diversity of subjects that, upon first reading this paper, I was at rather a loss as to where to start any investigation of his analysis.

As a first step, I decided to see what happened if the traditional autoregressive series were taken at a somewhat shorter interval than usual. I therefore assumed that the damping factor was $1-\varepsilon$ and that the period was θ, where both ε and θ are small. The first two serial correlations of the differences of this series would then be expected to be of the order

$$-\frac{\varepsilon}{2}+\frac{\theta^2}{2\varepsilon+\theta^2-2\varepsilon\theta}.$$

It is obvious from this formula that if ε and θ are both small, we should expect to have small serial correlations.

My next step was to substitute values for ε and θ in this formula. The first serial correlation coefficient for Kendall's series No. 21 calculated using the figures for the first week of every year was 0·66, and, since this was not far from the corresponding correlation coefficient of Kendall's artificial series $u_n - 1{\cdot}1\,u_{n-1} + 0{\cdot}5\,u_{n-2} = \varepsilon_n$, I decided to use the latter series in the further analysis. If this series were observed at monthly intervals, i.e., at one-twelfth the interval normally used, the damping factor would be 0·97 and θ would be 0·055 roughly. With these two values, the first serial correlation works out at 0·04. For narrower spacing, at weekly intervals, it works out at 0·01.

These results come out much as might be expected. Basically, the use of first differences of the original series gives rise to quantities which are proportional to the second differences of the correlogram. If the interval is small, these differences are correspondingly small, and so are the serial correlations. It is impossible to distinguish between different types of correlogram when we are working only with second differences of values from near the origin. It is not surprising that Professor Kendall concludes that the data behave almost like wandering series.

The above formula also throws some light on what happens when autoregressive schemes

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with the same random element are added together. It is fairly easy to demonstrate that this gives rise to an autoregressive scheme of higher order. Thus, the addition of two Markoff processes gives rise to a non-oscillatory second-order process (one for which θ^2 is negative). These higher processes will usually have constants such as θ, which will tend to increase the serial correlation coefficients of their differences. To put it simply, the increased complexity of the correlogram will increase the second differences. These results seem to indicate that Professor Kendall's conclusions are similar to those that would be reached by taking the usual autoregressive schemes at narrower intervals.

Concerning Professor Kendall's method of taking first differences, I remember when I first started at Rothamsted being shown a set of data of catches of insects in a light trap which was said to have been analysed by Professor Fisher. The method of analysis involved the use of differences between successive catches. It is interesting that this method is coming into use in the economic field to an increasing extent. Dr. Orcutt has been advocating it for some time, and he deserves some acknowledgment for his foresight. It is a very useful method, but it is necessary to beware of its limitations.

Obviously, it is restricted to series for which the serial correlations are high, so that if we carry out too complicated an analysis with the first differences there is a danger that we shall get to a position where we are, in effect, dealing with differences at a wider spacing, and our analysis may consequently be invalid. In general it will be valid, although there will be a limitation placed upon the narrowness of spacing by the errors of observation (in the simplest case by the errors of rounding-off) which will, if the observations are too close, swamp the normal random element. Also we shall run into problems of lag correlation for narrower intervals of spacing, for while it may be reasonable to assume that two events are simultaneous when our observations are yearly averages, it will often be altogether unreasonable when they are daily or weekly figures.

As to methods of dealing with trends in time series, I agree that it is difficult to distinguish between time trends and highly-correlated stochastic elements, but I do not think the position is as bad as Professor Kendall indicates. There are several rough and ready methods for use in this connection. One of these fits polynomials, examines the residuals in the light of the fitting, re-examines the fitting, and so on. A second method involves the use of moving averages (and includes the use of first differences as a special case) and the correction, if necessary, of the residuals to allow for the effect of the moving average. This is rather difficult, since initially it is desirable to maintain an open mind upon the form of average required to eliminate the trend. Yet another method employs the use of the spectrum of a series to discover its stochastic nature. This can be done, since trend is removed with the components of low periodicity.

We have had a stimulating paper, and the subject has benefited from the careful investigation carried out by Professor Kendall.

Mr. S. J. Prais: I wish to make three points. The first is that the reader must be grateful for the opportunity of examining analyses of really long economic time-series in which large sample theory can be used without the usual qualms. The use of an electronic computer to carry out the heavy numerical work is also noteworthy, and I wish to add my appreciation to that of earlier speakers.

Secondly, there is the question of the relevance of the type of autoregressive equation, the parameters of which Professor Kendall has been trying to estimate, to the type of dynamic theory economists usually deal with.

A dynamic economic system consists of a number of equations expressing relationships (generally demand or supply relationships) between economic variables, some of which at least involve time in an essential way in the form of time derivatives or time integrals. Since observations of economic phenomena are well separated in time, these relationships may without any considerable loss of generality be expressed in the form of difference equations. In a matrix notation such a complete set of equations may be written as

$$\mathbf{B}\,\mathbf{y} = \boldsymbol{\epsilon}, \qquad (1)$$

where $\mathbf{y}$ is a vector of n variables and $\mathbf{B}$ is a square matrix, the elements of which are polynomials in the delaying operator E^{-t}. The relationships are not supposed to be exact, so there is written on the right-hand side of the equation a vector of random variables ε with means zero. It is this type of economic relationship that economists usually investigate.

Now, in the usual way, if

$$\boldsymbol{\epsilon} = \mathbf{0}, \qquad (2)$$

the path in time of every economic variable in the system would be given by the same characteristic equation,

$$|\,\mathbf{B}\,|\; y = o, \qquad (3)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

where $|\mathbf{B}|$ is obtained by expanding the coefficients of the system (1) as a determinant, and (3) may be written in the form of a difference equation

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + \ldots a_p y_{t-p}. \quad . \quad . \quad . \quad . \quad (4)$$

Since in these circumstances the same difference equation will apply to all variables it is possible to investigate the dynamic properties of the system by examining the fluctuations of any one variable over time, no matter which variable is chosen. It is assumed that an argument of this kind lies at the base of Professor Kendall's investigations.

If, however, the equations of the system (1) are not exact, the autoregressive equation of the system will also not be exact. Further, each variable will have a different path over time; for (1) may then be "solved" for each variable in the form

$$|\mathbf{B}|\ y_i = \mathbf{B}'_i \epsilon = \eta_i, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

say, where $\mathbf{B}_i$ is the vector of co-factors of the ith column of $\mathbf{B}$. While the variances of the residuals of the behaviour equations (1) may be small so that good dynamic theory is possible, the variance of the residual of (5) may be very large; for, if the variance matrix of the ϵ is $\sigma^2 I$, the variance of η_i is given by

$$V(\eta_i) = \mathscr{E}\{\eta_i^2\} = \mathscr{E}\{\mathbf{B}'_i \epsilon \epsilon' \mathbf{B}_i\} = \sigma^2(\mathbf{B}'_i \mathbf{B}_i), \quad . \quad . \quad . \quad . \quad (6)$$

and the increase in variance depends on the size of the cofactors $\mathbf{B}_i$ or, generally, on the degree of ill-conditioning of the system.

As a simple example a Keynesian-type system was considered:

$$C = \alpha E^{-1} Y + \varepsilon_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7a)$$

$$I = \beta E^{-1} Y + \gamma E^{-2} Y + \varepsilon_2 \quad . \quad . \quad . \quad . \quad . \quad (7b)$$

$$Y = C + I, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7c)$$

where C, I and Y are consumption, investment and income; and α, β and γ are parameters. The autoregressive equation for consumption is

$$[1 - (\alpha + \beta) E^{-1} - \gamma E^{-2}] C = [1 - (\beta E^{-1} + \gamma E^{-2})] \varepsilon_1 + \alpha E^{-1} \varepsilon_2 \quad . \quad . \quad (8)$$

The variance of the expression on the right-hand side of (8) on the assumptions that $\mathscr{E}(\varepsilon_1^2) = \mathscr{E}(\varepsilon_2^2) = \sigma^2$ and $\mathscr{E}(\varepsilon_1 \varepsilon_2) = 0$ is

$$V(\eta) = (1 + \alpha^2 + \beta^2 + \gamma^2) \sigma^2, \quad . \quad . \quad . \quad . \quad . \quad (9)$$

which is always greater, and may be much greater, than σ^2. It may be noted that the values of η are not serially independent and not independent of lagged values of consumption.

It is, of course, true that the auto-correlations of an economic variable may be of negligible size if they are not generated by a dynamic system. But it follows from the above argument that, even if the dynamic behaviour relationships are well established, the auto-correlations of the variables will be weak on account of the increase in the residual variance of the transformed system. It may therefore be concluded that Professor Kendall's investigations of auto-correlations cannot in principle throw any light on the possibility of estimating the kind of dynamic economic relationships in which economists are usually interested.

The argument so far has been concerned with formal matters. My third and final point is concerned with the material nature of the markets investigated. These are share and commodity markets which are the best examples of markets that are dynamically perfect. That is, any expected future changes in the demand or supply conditions are already taken into account by the price ruling in the market as a result of the activities of hedgers and speculators. There is, therefore, no reason to expect changes in prices this week to be correlated with changes next week; the only reason why prices ever change is in response to unexpected changes in the rest of the economy; but when prices do change, as shown by Professor Kendall's calculations in Table 5, they all tend to change together.

In formal terms this could be expressed by saying that the system of behaviour relationships linking the stock market to the rest of the economy was ill-conditioned, and from the point of view of investigating the dynamic properties of the system it is therefore particularly unfortunate that Professor Kendall found it necessary to choose these markets for his investigations.

Professor F. Paish: I speak with some trepidation in such an assembly, but there are two things I should like to say. I am extremely grateful to Professor Kendall for his conclusion.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

As to his arguments I am not competent to judge. Many people in this world have spent many years trying to forecast what the stock markets are going to do on the basis of what they have already done. I always thought it futile, and am glad Professor Kendall has confirmed my opinion. It seems inevitable that where prices are based on expectation markets are as likely to go down as up. If the markets thought they were more likely to go up they would have gone up already. For this reason when there is option dealing, one always finds that the price of a double option is twice that of a single. Nevertheless, I should have thought that there was a possibility that some rather more complicated patterns might be discernible. The market depends on two different sorts of people—speculators and investors—or, in produce markets, hedgers. The former come in quickly but cannot stay in for long. The latter come in more slowly but stay. If the investors do not come in or do not come in as much as expected, the speculators get tired and have to sell. I should have expected some slight negative correlation after a lapse of some weeks. When the market has gone up sharply the initial rise is often followed by a fall as the speculators get tired of waiting for the investors to come in and take over. There are possibly patterns of that sort which could be distinguished in the data by somebody competent to do so.

Professor BARTLETT: I think that all I wanted to say has effectively already been said, but I should like to reiterate what seems to me to be the fundamental point. Professor Kendall in stressing the apparent randomness of his series has raised a paradox, but perhaps it may largely be resolved as a matter of interpretation. Incidentally, even if something is *apparently* random it does not necessarily mean that it *is* so; it may depend on something of which one is not aware. I have heard, for example, of a cotton firm in Manchester which in the good old days used to base its prices of cotton goods largely on the previous year's rainfall in Morocco, because they had a big export to Morocco, and if the rainfall there had been good the people would have a good harvest and could afford to pay high prices. If the annual rainfall were random, so would the annual prices appear so.

But the main point that one asks is: what are the chief characteristics of the data which Professor Kendall has been discussing? One is really not in a position to say from his paper because, as he has said, he is not able to quote the whole of the data, and if one works merely with differences one may be missing much of importance. It is true that the particular problem of predicting prices on the Stock Exchange can be discussed on the basis of the correlations of weekly differences, but these do not complete the summary of the variability and characteristics of the data, as previous speakers, and Professor Kendall himself, are aware. Mr. Quenouille has referred to second-order autoregressive series, so I will content myself with even simpler examples. Thus the price might be rising steadily, and in one sense be perfectly predictable; or we might have a stationary Markoff series in which the random residual became a negligible fraction of the total variance. (I do not think the total variance of Professor Kendall's series is given.)

I had the impression from the size of the cross-correlations in the paper that there may be more of a pattern than appears from the autocorrelations. It may be worth noting that if two autoregressive series are cross-correlated through a cross-correlation between the contemporaneous residuals, this cross-correlation will be preserved between the differences, even if the auto-correlations have been drastically reduced by differencing.

On a minor point, I was not altogether clear whether the trend-fitting at the end was on first differences, or on the original series.

Professor KENDALL: They were on the original series.

Professor BARTLETT: Yes, but the same notation was, I think, earlier used for first differences. If so, this might be made clearer.

Dr. K. S. RAO: Professor Kendall's criticism of the economist and especially the trade-cyclist is perhaps not of very wide generality. Large Sample methods of treatment of economic time-series, however attractive from the point of view of statistical theory, are difficult to justify from the point of view of economic theory, which such methods are intended to help.

A frequency distribution of a time-series of large length and the smallness of the first few serial correlation coefficients may not necessarily rule out systematic models, as can be seen by the following example, which is possibly one of a set that can be constructed.

Let m be an odd prime number and l an integer not divisible by m. Let n be a "large" integer. Consider a "time-series" of $N = n(m-1)$ terms defined as follows:
Let

$$\theta = 2\pi l/m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and

$$u_t = \frac{a}{\sqrt{m}} \sin 0\left[\frac{n+t}{n}\right] + a \sin 0\left[\frac{n+t}{n}\right] t, \quad . \quad . \quad . \quad . \quad (2)$$

for $t = 1, 2, \ldots N$, where $[x]$ denotes the greatest integer in x and a any given constant.

The Series in (2) is formed by using only the sine function. It can be noticed that, when we form a relative frequency table, we get a symmetric distribution with zero mean. Purely for purposes of simpler algebra, if we take n to be divisible by m, then

$$\bar{u} = \frac{1}{N} \sum_{t=1}^{N} u_t = 0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\text{Var } u_t = \frac{1}{N} \sum_{t=1}^{N} u_t^2 = \frac{a^2}{2} \frac{m}{m-1}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

If P_k, for $1 \leqslant k < m$, denotes the kth serial product of the series defined by the expression

$$P_k = \sum_{t=1}^{N-k} u_t u_{t+k}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

after some simplification we get

$$P_k = na^2 \left\{ \sum_{s=1}^{m-1} \left(\frac{1}{m} \sin^2 0s + \frac{1}{2} \cos 0sk \right) \right\} + O(1), \quad . \quad . \quad . \quad (6)$$

where the constant implied in O depends only on m, a^2 and k. It can be seen that the first term on the right-hand side of (6) vanishes.

Hence, if r_k is the kth serial correlation coefficient of the series in (2), then, for finite m, from (3), (4) and (6), it follows that

$$r_k = O\left(\frac{1}{N}\right) \text{ for } k = 1, 2, \ldots (m-1) \quad . \quad . \quad . \quad . \quad (7)$$

Professor Jevons: I am not competent to deal with the mathematics of Professor Kendall's paper, but I feel that the economist is entitled to say something about the assumptions which are subjected to mathematical processes. At one time I paid some attention to time-series, and what became perfectly plain to me was that variations of the price of an individual commodity were perfectly random, and this was more particularly the case with highly organized markets such as the Chicago wheat market or the London Stock Exchange. If the day-to-day fluctuations of these markets are examined they will be found to be due to all sorts of causes—rumours of wars, changes of weather, forecasts from agricultural departments, or again the operations of bulls and bears; so I am not in the least surprised that Professor Kendall did not claim any very significant results from his analysis. I would suggest that if he had taken the time series of, say, agricultural commodities in some backward country, where the market is not properly organized, as, for instance, India or Burma, he would have found many more interesting things in the way of correlation.

Professor Kendall mentioned trade cycles in his paper. I did a little work myself on that subject from 1907 on. I was anxious to see whether statistics would support my father's theory that commercial crises depended on causes coinciding with the sunspot cycle. I found that there are two trade cycles—one a short period of about $3\frac{1}{2}$ years, and the other a longer period which is usually ten years, or may be seven or eleven years. In order to put the idea to proof it seemed to me that we must take, not individual series of prices, but aggregate production—that is to say, if fluctuations in harvests produce any effect upon the activities of trade in general, it is not the result of fluctuations in one or more commodities, but of all the important commercial products. Therefore I took the production figures of the United States as far as available, and took weighted averages of these from year to year—weighted according to their average prices. I found quite remarkable evidence with regard to the shorter trade cycle. I later found, working on long series of statistics, both of prices and trade production, that the true period for the short cycle is 3·4 or 3·3 years. This period, practically one-third of ten years, has since been definitely established and accepted in the United States—the 40-month period, as they call it; and it is pretty obvious that the trade cycle is composed of two or three, or sometimes four, of these short periods, which are themselves fluctuating, probably, on the whole, with greater intensity than the longer periods.

This is a big subject. I should like to suggest that if you aggregate your figures (or sometimes you may take them individually, it depends on your purpose) you will find some interesting results. I only hope that Professor Kendall will continue his investigations along these lines.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The following contributions were received in writing after the meeting:

Mr. H. S. HOUTHAKKER: We are all indebted to the author for his work in the development and exposition of statistical methods, and his desire to apply some of these methods himself has much to commend it. Such applications, if based on a sound understanding of the material considered, can be of great benefit both to the subject under investigation and to the mathematical statistics. The qualification is important, for even the most refined methods, in fact especially those, will not lead to valid and interesting results unless they are applied to suitable data within an acceptable theoretical framework.

The evaluation of Professor Kendall's paper by the latter criterion is made difficult by the fact that there is no reference to a theoretical framework anywhere, nor indeed to work of others which the author may have had in mind. In his section 1, which is the only indication of the author's motives in undertaking this study, it is claimed that "it has been customary to analyse an economic time series by extracting from it a . . . trend . . . and then scrutinizing the residual portion for short term oscillatory movements and random fluctuations." This sentence would be correct if it began "it was customary twenty or thirty years ago." From about 1930 the development of econometrics has led to a general conviction among economists that little purpose is served by studying individual time series separately, and that they become interesting only when linked to each other in economically meaningful relations. The models thus constructed may well be of an autoregressive type, but trends or short-term oscillatory movements occupy only a minor place in them. A time series like the one for first differences of wheat prices may appear purely random if considered in isolation, yet regression analysis will soon reveal that the means of these apparently random differences are functions of supply and demand factors. And can there be any doubt that the movements of share prices are connected with changes in dividends and the rate of interest? To ignore these determinants is no more sensible or rewarding than to investigate the statistical properties of the entries in a railway time-table without recognizing that they refer to the arrivals and departures of trains.

It would nevertheless be wrong to dismiss this inquiry as merely the backwash of the Yule tide. Professor Kendall's iconoclastic efforts, even though directed against straw men, point to an interesting conclusion which is almost exactly the opposite of his own conclusion (*c*) in section 3. The series considered all refer to variables which in most econometric models would be regarded as endogenous. In recent statistical work much attention has been given to the complicated nature of the errors in these endogenous variables; it would make our work much easier if they were in fact random, for they could then be treated as if they were predetermined and the model accordingly simplified. However, the incompleteness of the author's analysis makes this conclusion so tentative that it would not yet seem safe to act on it.

Dr. D. R. COX: The serial correlations in Professor Kendall's Table 3 are all small, but nevertheless the correlograms for the different series behave in a remarkably similar fashion. This can be seen in an elementary way by considering the number of negative coefficients:

Lag	1	2	3	4	5	6	7	8
Number of negative coefficients out of 19	1	4	3	13	16	18	16	14

9	10	11	12	13	14	15	16	17	18	. . .
13	10	7	1	6	13	6	0	0	1	. . .

Similarly for the cross-correlations in Table 5 we find

Lag	1	2	3	4	5	6
Number of negative coefficients out of 56	5	10	13	31	45	47

In both cases there is very strong evidence for the existence of a non-random component, presumably of approximately the same structure for all or most of the 19 series. This, of course, does not affect Professor Kendall's point that the correlations are small, and hence useless for short-term prediction.

It is worth pointing out explicitly that the presence of certain types of non-randomness is shown, not by the occurrence of high serial correlations, but by other features of the correlogram, such as the existence of a run of coefficients all with the same sign. For example if the successive differences of price were completely random, price itself would undergo a simple random walk and would not be stationary. If there were in addition some tendency to return to a stable level of price, the correlations of differences would be small and negative (see, for example, Table 2, last column.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

As another example, Mr. W. L. Smith and I, in some recent work to appear in *Biometrika*, have discussed a special time-series arising in neuro-physiology, and have shown that a certain simple completely deterministic time-series, relevant to the neurological problem, is indistinguishable from a random series by the conventional correlogram method.

The problem, raised by Professor Kendall in Section 1, of dealing with long-term and short-term movements in one model arises in an acute form in investigations of irregularity in textile processing, notably in drawing and spinning. Drawing is a process of successive attenuation, each stage introducing an irregularity. In the final time-series the irregularities from the last stage have a characteristic length of a few cm., while the irregularities from the initial stages spread over several hundreds of yards. A method that is useful here is analysis of variance, in which the total variation is divided into variation between and within lengths l, and the coefficient of variation between the means of different sections of length l is plotted against l. This method was suggested by Tippett, and later by Yule under the name of the lambdagram. It is roughly equivalent to integrating the correlogram twice, and so is sensitive to runs of correlations all of the same sign. A related method has been useful in the neurological problem mentioned above.

Mr. A. S. C. EHRENBERG: Whilst it is difficult to describe time-series fully, they seem to possess features of some relevance apart from the first differences discussed by Professor Kendall. For example, the two wheat price series (§§6–19) are measured in cents on a scale with a more or less absolute minimum, and the mean, the scatter and any general trends of the primary data might be of interest. "End-effects" would be expected if the mean is low, and "scaling effects" generally. Thus the threefold increase in variance of the first differences of the weekly wheat series (§§9–11) might be connected with an upward trend of the *primary* data. (The constant mean referred to in §11 is presumably that of the first differences.) Since heteroscedasticity greatly reduces the utility of correlation coefficients, any mathematical transformation to counteract it might simplify the description of the data. Supposing that a transformation suggested by the trend (if any) could be found which gives homoscedasticity, it would of course not necessarily be useful to think of the original change in variance as just a scaling effect. But this might be so if the same transformation were to simplify many different price series, or perhaps if it were closely related to the economists' ideas on "real" prices. Information on such points could, one feels, be given simply enough. The scaling argument, for example, could not be countenanced at all in the *absence* of any upward trend in the primary series.

Some of the relevant information is admittedly contained in the description of the first differences given in the paper, though extracting it may raise more problems than it settles. Thus, there does appear to be a trend, of 69 cents, in the primary weekly wheat prices—entirely after the Great War—whilst in the same data treated as *monthly* instead of *weekly* figures (series 21, §16) the trend is only 28 cents, omitting one value at each extreme (or 43 cents for the whole series). No other deductions can be made about the variability of the primary series, at least not without some wild assumptions about their serial correlations. For example, if one supposed that in fact only the linear trend was striking, and that the second order serial correlation was no more than two-thirds of the first order correlation, the standard deviation would seem to be about five cents or less (and the first order correlation already as high as about ·75). In as far as such a standard deviation would then be anywhere near the truth—this would be likely in view of the rejection of widely outlying values (footnote, §9) of the order of 40 cents—these trends and discrepancies seem striking enough at least to deserve being explained away.

Turning to Professor Kendall's lack of sympathy with aggregative series and their "spurious" serial correlations (e.g., §§3, 23, 28), it may avoid confusion to mention that the correlations are *not* spurious in the sense that they *do* describe such series. Difficulties arise when one wishes to compare different aggregative series, let alone propound any so-called "causal" arguments. In Professor Kendall's illustrative example (§28), the correlation between the aggregative series E and F, each made up of n primaries, depends not only on the intercorrelations, but also on the *number*, of primaries. (Equation 12 may be a little misleading here since the n cor $(\varepsilon_i\varepsilon_i)$ in the denominator are unity.) Thus the correlation between E and F varies from ·1 ($n = 1$) through ·14 ($n = 2$), ·17 ($n = 3$), ·23 ($n = 15$—Kendall's example) to a limit of ·25. The "spurious" element arises because by averaging similar readings the strength of the relationship is affected, and not only the accuracy of its determination. This phenomenon is of course one of the reasons why correlation coefficients are used less and less frequently elsewhere—nothing like it seems to occur with most models of the analysis of variance kind, for example.

It should perhaps be remembered that in aggregating time-series like this, we are not necessarily averaging similar readings in the usual sense (e.g., sampling from an infinite population), since the supply of relevant time-series satisfying the original requirements (§28), that cor $(\varepsilon_i\varepsilon_j) = \cdot 4$ $(i \neq j)$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and cor $(\varepsilon_i \eta_j) = \cdot 1$, may be strictly limited. There can, however, be little doubt that when the primary series are available, their serial correlations will be more useful than those of some aggregative series. For example, suppose that one wishes to compare the behaviour of two sets of data and that one of the primary series is missing, or different, in one of the sets of data. Then if the two sets of serial correlations for the aggregative series are identical, the two sets of data cannot be the same, as judged by the serial correlations of the primaries, whilst if these latter are identical, the correlations of the aggregative series would not show it.

Professor KENDALL, in reply: I should like to thank the proposer and seconder for their remarks and all the contributors to a helpful discussion. I made this paper as little mathematical as possible in the expectation that the mathematicians would all agree with me and the economists perhaps disagree. But as it has turned out, the mathematicians are doubtful, and the economists in their conclusions are inclined to agree.

Professor KENDALL subsequently wrote as follows:

With much of the discussion I agree and will confine myself to points of difficulty or disagreement.

(*a*) As Professor Champernowne points out, I am not attacking the use of index numbers for customary purposes, and I agree with points made by him, Professor Bartlett and Mr. Ehrenberg that "spurious" is not a good word to describe the serial correlations found in series of index-numbers. At the same time, it seems to me necessary to proceed very cautiously in the interpretation of serials in aggregative series, especially if they are used to estimate autoregressive periods. The problem is similar to that of measuring correlation in divisible units, and one has to be sure that one is measuring a property of the system itself, not merely a property of aggregation.

(*b*) In his observations on rough and ready methods of trend-determination Mr. Quenouille has, I think, failed to see my point of view. I do not deny that there are methods. What troubles me is whether they have any purpose except a purely descriptive one.

(*c*) Dr. Rao is quite correct in pointing out that one can construct non-random series for which a set of serial correlations vanish. But if we find in practice a set of small serial correlations we are, I think, on safe ground in supposing that successive values are nearly independent, as against the alternative that the generating system consists of a set of harmonic oscillations with very special periods.

(*d*) I look forward to seeing Dr. Cox's work and agree with him except on one point. He calls attention to patterns of signs in the serial correlations which indicate that, although small, the correlations are not haphazard. I think he is probably right, but I do not regard the point as settled beyond all doubt. Certain runs of signs might occur from bias in the estimations or from the fact that they may be serially correlated (by chance) even in random series. I propose to settle this question by constructing correlograms of a series of normal independent variates.

(*e*) Professor Allen, Professor Champernowne, Mr. Prais and particularly Mr. Houthakker all raise the question how far can one profitably analyse time-series without a theoretical model in the background? The general question of model-building in statistics and economics is one which I propose to discuss at length on another occasion. All I need say at this stage is that I think it is futile to lay down any rules as to whether fact should precede theory or theory fact. Scientific discovery proceeds by an alternation of the two. I feel entitled, however, to protest at some of Mr. Houthakker's comments. I could perhaps overlook his description of my work as to some extent Yulean backwash because of the mordancy of the phrase. But his claim that "even the most refined methods . . . will not lead to valid and interesting results unless they are applied to suitable data *within an acceptable theoretical framework*" seems to me the negation of the scientific spirit. I have tried to elicit certain facts about economic series. They may be wrong, but if they are correct they are facts, irrespective of any theoretical framework.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Harry Brierley.
Ronald Edgar Brook.
Thomas Peter Browell.
Peter Richard Browning.
Charles Frederick Evinton.
Derek John Finch.
Denys William Humphries.
Michael Harold Kreps.
John Kenneth Lambert.
George Gordon Lilley.
Denis Walter McAllister.
Ronald Macer.
Thomas Alma Perkins.
Robert Brian Sanderson.
Om Chandra Sharma.
Robert John Taylor.
Alan Arthur Walters.
John Wrigley.

Corporate Representative

Peter Kenneth Wiggs, *representing* The Morgan Crucible Co. Ltd.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Price of Gold and the Purchasing Power of the Pound Sterling

By H. Frankel
Institute for Research in Agricultural Economics, University of Oxford

It was widely recognized during most of the interwar period that changes in the general level of agricultural prices—as distinct from fluctuations in prices of individual agricultural commodities—were largely the results of monetary changes; and that the Bank of England's price of gold under the gold standard not only determined the foreign exchange of the £ (and thus import and export prices), but also the volume of currency and credit and thereby, in considerable degree, internal economic activity. It was said in the mid-twenties that although monetary questions might seem to be far removed from agriculture, "the plain fact [is] that the root causes of the agricultural crisis were far removed from agriculture". In monetary deflation lay the origin of the depression, and "it was an operation which involved not merely the monetary policy of the Treasury and banks of the United Kingdom, but those of other countries, particularly the United States" (Enfield, 1924, pp. 15, 68). The Report of the Committee on Stabilization of Agricultural Prices emphasized that historically it was the fluctuations in agricultural prices *as a whole* which have been of the greatest importance and have had the most far-reaching consequences. "The explanation of such general variations in prices (is) properly attributed to monetary causes, that is to say, to changes in the relation of the total available means of payment in a community to the total quantity of goods and services to be marketed. . . . The history of the nineteenth century seems to show in a manner which is beyond dispute that variations in the purchasing power of money have been responsible for greater misfortune to agriculture than had arisen from *any other single cause*. . . . In the true interests of agriculture, as of other industries, it is as important to avoid a recurrence of price inflation as to escape from the danger of further deflation" (Min. of Agriculture, 1925, pp. 7–8, 10–11, 17). In 1935 it was maintained in the United States that "for 75 years before the World War, world monetary stocks of gold had to increase at the same rate as the world physical volume of production in order to maintain stable commodity prices in England. If gold stocks increased more rapidly than other things, prices rose; if they increased less rapidly, prices fell. . . . For a stable and equitable price level, world monetary stocks of gold must first be large enough to sustain the price level to which society is adjusted and must thereafter increase at the same rate as the production of other commodities, which before the war was about 3·15 per cent. per year. . . . The price of an individual commodity may rise or fall because of changes in the supply of it or demand for it, but the average price of commodities cannot change materially without a world-wide change in the value of gold or a change in the price of gold in the United States" (Warren and Pearson, 1935, pp. 94, 131, 184–5).

For a number of reasons the pre-occupation in the inter-war years was with falling prices and not with rising prices, with deficiency of demand and not with deficiency of supply (supply questions were discussed mainly with regard to the distribution of individual agricultural commodities). To-day the opposite is the case, although it is not quite clear how much the change in the role of gold as the guiding and measuring factor of internal economic activity—while retaining some influence upon international trade and balance of payments—has contributed to this state of affairs. The purpose of this note, however, is not to suggest any causative relation of changes in the gold supply or price being followed of necessity by changes in commodity prices, but to present as information the available data on gold prices, compared in the various tables and charts with other price series, and to measure the value of the £ in terms of these prices.

The Price of Gold

The price of gold in London in 1914–50 was either fixed by the Bank of England or determined by the open market. At times the former was ineffective (from September, 1919, to May, 1925, and from September, 1931, to March, 1939) and even was reproducing the market price (from

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

March, 1939, to September 1939); at other times the market price was effectively fixed by the Bank of England price (before September, 1919; from May, 1925, to September, 1931; and from September, 1939, onwards).

From August, 1914, to September, 1919, and again, beginning with September, 1939, transactions in gold were confined to the official level; from September, 1919, the price generally quoted was that per fine gold while before that date the price was per standard gold. The price series in this note were, therefore, divided into three parts: (1) for 1913–19, when in the main there was no free market and the price quoted was per standard gold; (2) for 1919–39, when there was a free market and the price quoted was per fine gold; and (3) for 1939–49, when again there was not a free market but when the price quoted was also per fine gold.

1870–1914.—In 1870–1914 (and in 1925–31) the price of gold on the free London market was determined by the Bank of England's legal obligation to provide an unlimited guaranteed market at fixed prices. The Bank's sale price of gold was at the statutory rate of £3 17*s.* 10½*d.* per standard ounce and the buying price at the rate of £3 17*s.* 9*d.* per standard ounce.

1914–19.—From August, 1914, to September, 1919, private dealings in gold were suspended; there was a legal prohibition of gold exports and of the melting of gold coin, and the importation of gold bullion was reserved to the Bank of England (Parliament, 1914*a*; Gregory, 1929, p. 324). But the Bank's legal obligation of selling and buying gold at the pre-1914 rates remained unaltered; in addition to bank notes, also currency notes, which were issued after August 6th, 1914, by the Treasury, were also convertible on demand into gold coin at the Bank of England. However, the public was appealed to in every possible way, in Parliament, in the Press, by the Bank of England and by the other banks not to ask for gold. Anyone who did so, they were told, was assisting the enemy more effectively probably than if he were to take up arms for them (Parliament, 1914*b*). As a result there was no demand and notes gradually took the place of gold in circulation (Feavearyear, 1931, p. 303). The view was maintained that throughout the war gold in London had not changed in value since before the war (Parliament, 1919, p. 8). However, there was a demand for gold for industrial purposes, and the small amounts available were sold at prices reaching even £6 per fine ounce and more. The output of gold within the British Empire was commandeered by the Bank of England on the British currency basis of £3 17*s.* 9*d.* per standard ounce. This restriction was removed on September 12th, 1919, and gold imported into the United Kingdom was allowed to be sold to the highest bidder (Shrigley, 1935, p. 75).

Price of Gold, Average of Daily Quotations on the London Market, 1913–19
(Shrigley, 1935, pp. 90–104)

Year	*Annual Average Price per Standard Ounce*[a]		
	£	*s.*	*d.*
1913	3	17	9·00
1914	3	17	9·04
1915	3	17	9·00
1916	3	17	9·00
1917	3	17	9·00
1918	3	17	9·00
1919[b]	4	10	1·03

[a] Standard ounce (11/12 fine) from 1913 to 1918; fine ounce in 1919. Quotations were changed in September, 1919, from the standard ounce to a fine ounce basis. The Bank's price changed to that basis in March, 1939 (it had been valuing its gold on a fine ounce basis since the passing of the Currency and Bank Notes Act, 1928). The price of £3 17*s.* 9*d.* per standard ounce is equal to £4 4*s.* 9·82*d.* per fine ounce.

[b] £4 18*s.* 8*d.* on September 12th, 1919, rising to £5 11*s.* 3*d.* on December 12th, 1919.

1919–39.—From September, 1919, to May, 1925, the Bank of England buying price of gold remained unaltered at the legal rate of £3 17*s.* 9*d.* per standard ounce. But war-time restrictions on the export of gold continued, and an exception was made that any gold produced within the Empire and imported into Britain under any arrangement approved by the Treasury might be re-exported under the terms of that arrangement. As a result of the continued legal fiction of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

convertibility of paper currency into sovereigns and sovereigns into gold bullion, the paper pound sterling was nominally kept at parity with gold. However, it was kept at parity not with gold in general but with gold in Britain without a licence for export. In the view of the South African gold producers the London market price of gold (which was much higher than the Bank of England's price) expressed, not the value of the gold, but the value of the gold plus the value of the permit to export. Legally this question was decided in favour of the market price.*

*Price of Gold, Average of Daily Quotations on the London Market, 1919–39**

Year	*Annual Average Price per Fine Ounce*		
	£	*s.*	*d.*
1919	4	10	1·03
1920	5	12	11·52
1921	5	7	0·50
1922	4	13	3·80
1923	4	10	2·90
1924	4	13	8·30
1925	4	5	5·60
1926	4	4	11·10
1927	4	4	11·20
1928	4	4	11·20
1929	4	4	11·35
1930	4	4	11·93
1931	4	4	6·23
1932	5	18	0·82
1933	6	4	10·40
1934	6	17	7·85
1935	7	2	1·24
1936	7	0	3·45
1937	7	0	9·10
1938	7	2	6·66
1939([a])	7	15	1·20

([a]) Monthly averages.

* (Bank of England, October, 1932, 1934, 1936, 1938; November, 1939; January, 1940; Royal Mint, 1925–39; Shrigley, 1935, pp. 90–104.)

During 1920 the price fluctuated throughout the year; the highest daily price was £6 7*s.* 4*d.* on February 5th, 1920, and the lowest £5 3*s.* 0*d.* on April 6th, 1920. In 1921 the price fell from a maximum of £5 15*s.* 11*d.* on January 3rd, 1921, to a minimum of £4 17*s.* 8*d.* on December 21st, 1921. The price continued to fall throughout 1922, the highest daily quotation being £4 18*s.* 4*d.* on January 5th, 1922, and the lowest £4 8*s.* 5*d.* on December 13th, 1922. In 1923 the highest price paid was £4 16*s.* 11*d.* on November 19th, 1923, and the lowest price paid was £4 7*s.* 5*d.* on February 21st, 1923. In 1924 the price fell again and, similarly as in 1921–2, the highest daily quotation was at the beginning of the year, £4 16*s*, 10*d.* on January 3rd, 1924, and the lowest at the end of the year, £4 8*s.* 0*d.* on December 30th, 1924. The Gold Standard Act, 1925, which came into operation on May 13th, restored the sales of gold by the Bank of England at pre-1914 prices. The market price had decreased previously from £4 7*s.* 9*d.* on January 1st, 1925, to £4 4*s.* 11½*d.* on April 29th, 1925.

* In the case of Union-Castle Mail Steamship Company *v.* Standard Bank of South Africa and National Bank of South Africa, before Mr. Justice Greer, King's Bench Division, in 1923. The plaintiffs' case was that under two contracts of 1913–14 it was agreed that they would forward all raw gold shipments at the rate of 4*s.* 3*d.* per cent. on the value of the gold shipped; and that the value of gold in 1919–23 was not the official Bank of England value, which continued to be inserted in the bills of lading, but the London market value. For defence it was maintained, however, that the word "value" in the agreements meant the amount of gold coin one could make out of raw gold, and that the London market value was not the value of gold as such but of the gold plus the permit to export. The judgment of the court was that the word "value" of gold in the agreements, like the value of any other commodity, was the highest price which, under existing conditions, would be bid for gold in the London market in English currency; the plaintiffs were consequently entitled to recover from the defendants the difference between the values as stated in the bills of lading and the value so estimated (Lloyd's, 1923, pp. 309–315).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

From May, 1925, to September, 1931, pre-1914 conditions—apart from gold coinage—were restored. In September, 1931, the convertibility of the paper pound into gold was suspended and although the Bank's prices remained at £3 7*s.* 10½*d.* and at £3 17*s.* 9*d.* until March, 1939, they could not determine the market price in the absence of an effective selling price of gold. The market price of gold until the outbreak of war in September, 1939, was based on either the sterling-dollar or the sterling-franc cross rate.

Sales of gold by the Bank of England were suspended by the Gold Standard (Amendment) Act, 1931, which came into operation on September 21st, 1931, and the price rose rapidly. The monthly average of daily quotations in August, 1931, was £4 4*s.* 11·17*d.*; in September, 1931, £4 11*s.* 2·70*d.*; in October, 1931, £5 6*s.* 3·44*d.*; in November, 1931, £5 10*s.* 8·95*d.*; in December, 1931, £6 2*s.* 5·60*d.* In 1932 the price fluctuated throughout the year, the highest monthly average being £6 5*s.* 8·88*d.* in December, 1932, and the lowest monthly average £5 10*s.* 3·35*d.* in April, 1932. In 1933 and 1934 there was a slow continuous upward movement of the price of gold, which changed little between 1935–9.

1939–49.—The Currency and Bank Notes Act, 1939, which came into operation on February 28th, 1939, changed the Bank's price of gold (the Act also removed the obligation to buy and pay for in notes any gold offered to it). It required the gold bullion and coin in the Issue Department of the Bank of England to be valued weekly at the market price of the day, instead of at the selling price of £3 17*s.* 10½*d.* per ounce standard of gold. (The latter price was commonly known as Mint Price.) Consequently the Bank of England return on March 1st, 1939, valued the gold bullion in the Issue Department at £7 8*s.* 5*d.* per fine ounce, the market price of the day (Royal Mint, 1939–44; Bank of England, March, 1939). From September 5th, 1939, and throughout the war and post-war years dealings in gold were confined to official channels and to dealers authorised by the Treasury, also the export of gold was prohibited. The price of gold fixed by the Treasury and the Bank of England was the market price, and on this basis transactions were concluded. The free market of gold remained suspended (Parliament, 1939; 1947).

Bank of England Price of Gold, 1939–49 (Treasury, 1947–50)

Year		*Per Fine Ounce*		
		£	*s.*	*d.*
1939	From September 5th .	8	8	0
1940	. . . . .	8	8	0
1941	. . . . .	8	8	0
1942	. . . . .	8	8	0
1943	. . . . .	8	8	0
1944	. . . . .	8	8	0
1945	From January 1st . .	8	8	0
	From June 6th . .	8	12	3
1946	. . . . .	8	12	3
1947	. . . . .	8	12	3
1948	. . . . .	8	12	3
1949	From January 1st . .	8	12	3
	From September 19th .	12	8	0

The market price rose on January 5th, 1939, to the then record price of £7 10*s.* 5*d.* Later the price fell, and from February 1st to August 24th varied only between £7 8*s.* 2*d.* and £7 8*s.* 7½*d.* On September 1st it rose to £8 0*s.* 0*d.* The market was closed on September 2nd–4th, and on September 5th, 1939, the price of gold was fixed at £8 8*s.* 0*d.* a fine ounce, a figure which was maintained unchanged till 1945, when it was increased on June 6th to £8 12*s.* 3*d.* This price remained in force until September 19th, 1949, from which date, and throughout 1950, the price was fixed at £12 8*s.* 0*d.* per fine ounce.

The Purchasing Power of Pound Sterling

The value of money is expressed in the goods and services it can buy and changes in the purchasing power of money, therefore, depend upon, and vary inversely with, changes in prices of these goods and services.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The price of gold, as shown in the table on pp. 40–41 and charts on pp. 42–44, has increased from 1911–13 to 1950 by 192 per cent. Accordingly, the purchasing power of one pound sterling in 1911–13 was equal in terms of gold to 6·8*s.* in 1950; in terms of agricultural prices to 5·8*s.* in 1950, in terms of wholesale prices to 5·1*s.* in 1950 and in terms of retail prices to 8·7*s.* in 1950. Another measure is provided by the index published in the National Income White Paper, which is estimated to cover the whole of consumer expenditure. That index does not go further back than 1938, but figures for 1910, 1920, 1930 and 1938–50 were given by the Chancellor of Exchequer in the House of Commons. On the basis of these data, which are shown in the Appendix, the following estimates of the changes in the purchasing power of £ are available (1910 = 100).

Purchasing Power of £.

Year	*s.*	*Index*
1900	21·0	105
1910	20·0	100
1920	7·8	39
1930	12·2	61
1938	12·4	62
1939	12·0	60
1940	10·2	51
1941	9·2	46
1942	8·6	43
1943	8·4	42
1944	8·2	41
1945	8·0	40
1946	7·8	39
1947	7·2	36
1948	6·8	34
1949	6·6	33
1950	6·4	32

Indices of agricultural and retail prices, as well as the National Income White Paper consumer goods index, include a varying amount of subsidies (their greatest weight fall, of course, on the retail prices or cost of living index since subsidies are concentrated on essential commodities and mainly at the retail end of distribution); and even the wholesale price index is not free from subsidies. It seems, nevertheless, whatever measure is taken, that agricultural wages expressed in real terms were in 1950 higher than 1911–13 or 1914. The purchasing power of the wages of an agricultural labourer increased between 1911–13 and 1950 by about 82 per cent. in terms of gold, by about 60 per cent. in terms of agricultural commodities, by 41 per cent, in terms of goods at wholesale prices and, which probably is most adequate as a measure of real wages, it increased between 1914 and 1950 by about 128 per cent. in terms of consumer goods at retail prices.

The subsidised value of £ in 1950 in terms of commodities other than gold was more in the neighbourhood of 5*s.* than 6*s.* The purchasing power of £ in terms of gold in 1950 was higher than the purchasing power of £ in terms of agricultural commodities, and also of other commodities at wholesale prices (and probably also in terms of goods at retail prices if the effect of subsidies were removed)* A similar situation obtained (*a*) in 1914–19 when there was no open market of gold, (*b*) in 1919–25 when a policy of deflation was pursued, (*c*) in 1925–31 when the gold standard was restored at a too high value of the £ in terms of gold as was recognized after 1931, and (*d*) in in 1939–50 when gold was again controlled. The only period during which the purchasing power of £ in terms of gold was lower than the purchasing power of £ in terms of other commodities was according to the price series available, the period 1931–39, i.e., after the severe fall in prices during 1929–31, and when there was less government interference as far as the price of gold was concerned than at any other period since 1914 or earlier, attention being in 1931–9 directed rather towards the acquisition of adequate stocks of gold than towards an *a priori* fixed price.

* The purchasing power of £ in terms of retail prices reflects, of course, only the internal purchasing power of £, and there is some justification, therefore, not to deduct subsidies or their counterpart in taxation, in order to arrive at some "true" internal purchasing power. But it may perhaps be mentioned that if the war-time increase in subsidies were removed together with the war-time increase in direct taxation, retail prices in 1948, as estimated in Appendix B, would have been lower and not higher.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

*The Purchasing Power of £ in Terms of Gold, Agricutural, Wholesale and Retail Prices**

Year	Bank of England Price of Gold per standard oz. £ s. d.	Bank of England Price of Gold per fine oz. £ s. d.	Annual Average Market Price of Gold: Per fine oz. s.	Per fine oz. Index	£ Purchasing Power measured by Index s.	Agricultural Prices: General Index	£ Purchasing Power measured by Index s.	Wholesale Prices (Sauerbeck): Index	£ Purchasing Power measured by Index s.	Retail Prices (Cost of Living): Index	£ Purchasing Power measured by Index s.	Agricultural Wages: s.	Index
1911–13	3 17 9·00	Not quoted	84·8	100	20·0	100[i]	20·0	100	20·0	—	—	17·2	100
1914	3 17 9·04	,,	,,	,,	20·0	101	19·8	102	19·6	100 (July)	20·0	18·0	105
1915	3 17 9·00	,,	,,	,,	,,	127	15·7	130	15·4	123	16·3	n.a.	n.a.
1916	Ditto	,,	,,	,,	,,	160	12·5	164	12·2	146	13·7	n.a.	n.a.
1917	,,	,,	,,	,,	,,	201	10·0	211	9·5	176	11·4	25·0	145
1918	,,	,,	,,	,,	,,	232	8·6	231	8·7	203	9·9	30·5	177
1919	,,	,,	90·1	106	18·9	258	7·8	248	8·1	215	9·3	37·9	220
1920	,,	,,	113·0	133	15·0	292	6·8	302	6·6	249	8·0	43·4	252
1921	,,	,,	107·0	126	15·9	219	9·1	187	10·7	226	8·8	43·7	254
1922	,,	,,	93·3	110	18·2	169	11·8	158	12·7	183	10·9	31·3	182
1923	,,	,,	90·2	106	18·9	157	12·7	154	13·0	174	11·5	27·9	162
1924	,,	,,	93·7	110	18·2	161	12·4	167	12·0	175	11·4	27·9	162
1925	,,	,,	85·5	101	19·8	159	12·6	164	12·2	176	11·4	31·0	180
1926	,,	,,	84·9	100	20·0	151	13·2	151	13·2	172	11·6	31·3	182
1927	,,	,,	,,	,,	,,	144	13·9	147	13·6	167·5	11·9	31·5	183
1928	,,	,,	,,	,,	,,	147	13·6	143	14·0	166	12·0	31·3	182
1929	,,	,,	,,	,,	,,	144	13·9	137	14·6	164	12·2	31·7	184
1930	,,	,,	85·0	,,	,,	134	14·9	116	17·2	158	12·7	31·9	185
1931	,,	,,	92·5	109	18·3	120	16·7	99	20·2	147·5	13·6	31·7	184
1932	,,	,,	118·1	139	14·4	112	17·9	95	21·1	144	13·9	31·3	182
1933	,,	,,	124·9	147	13·6	107	18·7	94	21·3	140	14·3	30·8	179
1934	,,	,,	137·7	162	12·3	114	17·5	98	24·5	141	14·2	30·8	179
1935	,,	,,	142·1	168	11·9	117	17·1	99	20·2	143	14·0	31·7	184
1936	,,	,,	140·3	165	12·1	120	16·7	106	18·9	147	13·6	32·2	187
1937	,,	,,	140·8	166	12·0	131	15·3	123	16·3	154	13·0	33·3	194
1938	,,	,,	142·6	168	11·9	130	15·4	108	18·5	156	12·8	34·6	201
1939	,,[a]	,,[b]	155·1[g]	183	10·9	131	15·3	113	17·7	158	12·7	34·9	203
1940	Not quoted	8 8 0	168·0	198	10·1	183	10·9	154	13·0	184	10·9	43·0	250
1941	,,	Ditto	,,	,,	,,	220	9·1	171	11·7	199	10·1	49·3	287
1942	,,	,,	,,	,,	,,	234	8·5	182	11·0	200	10·1	59·9	348
1943	,,	,,	,,	,,	,,	237	8·4	187	10·7	199	10·1	60·5	352

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Year	Bank of England Price of Gold per standard oz. £ s. d.	Bank of England Price of Gold per fine oz. £ s. d.	Annual Average Market Price of Gold: Per fine oz. s.	Per fine oz. Index	£ Purchasing Power measured by Index s.	Agricultural Prices: General Index	£ Purchasing Power measured by Index s.	Wholesale Prices (Stuerbeck): Index	£ Purchasing Power measured by Index s.	Retail Prices (Cost of Living): Index	£ Purchasing Power measured by Index s.	Agricultural Wages: s.	Index
1944	Not quoted	8 8 0	168·0	198	10·1	243	8·2	193	10·4	201	10·0	65·0	378
1945	,,	8 8 0(c) / 8 12 3(d)	170·5(h)	201	10·0	250	8·0	198	10·1	203	9·9	69·1	402
1946	,,	8 12 3	172·2	203	9·9	265	7·5	224	8·9	203·5	9·8	74·2	431
1947	,,	Ditto	,,	,,	,,	309	6·5	277	7·2	203(i) (Mid-June)	9·9 (Mid-June)	83·3	484
1948	,,	,,	,,	,,	,,	318	6·3	313	6·4	219	9·1	90·0	523
1949	,,	8 12 3(e) / 12 8 0(f)	194·3(i)	229	8·7	333	6·0	330	6·1	225	8·9	93·2	542
1950	,,	12 8 0	248·0	292	6·8	345	5·8	392	5·1	231	8·7	94·9	552

(a) Until March 1st, 1939. (b) From March 1st, 1939, to September 1st, 1939, the market price, which varied from £7 8*s.* 5*d.* to £8 0*s.* 0*d.* From September 5th, 1939, the fixed price was £8 8*s.* 0*d.* (c) Until June 5th, 1945. (d) From June 6th, 1945. (e) Until September 18th, 1949. (f) From September 19th, 1949. (g) Monthly averages (h) (January–May 168*s.* and 172*s.* 3*d.* June–December, 1945). (i) Monthly averages (January to mid-September, 172*s.* 3*d.* and mid-September to December, 1949, 248*s.*). (j) Post-1927 adjusted to 1911–13 base. (k) Taking the average of the index number for 1911, 1912 and 1913 on the 1867–77 base as 100. (l) The 1914 index was discontinued in 1947 and substituted by the new Interim Index of Retail Prices with 1947 as base. For present purposes it was assumed that the old index would have shown similar changes in 1947–50 as the new index. (m) Average weekly minimum rates for ordinary adult male farm workers (or comparable rates). The average wage for 1911–13 was arrived at by multiplying the wage rate for 1914 of 18*s.* (Ministry of Agriculture and Fisheries, Report of Proceedings under the Agricultural Wages (Regulation) Act, 1924, for the year ending September 30th, 1925), by the average index for 1911–13 = 108 (1900 = 100) and dividing the product by the index for 1914 = 112·7 (1900 = 100) (19*th Abstract of Labour Statistics, U.K.*). Wage rates for other years were obtained either directly or indirectly from the index 1914 = 100 (wage rate 18*s.*) and shown in sources under references (Royal Mint, 1939–44; Bank of England, March, 1939).

* *Gold Prices.*—Sources shown under references (Royal Mint, 1925–39; Bank of England, October, 1932, 1934, 1936, 1938, November, 1939; January, 1940; Shrigley, 1935, pp. 90–104; Treasury, 1947–50).

Agricultural Prices.—Agricultural Statistics, England and Wales; Annual Abstract and Monthly Digest of Statistics; Farm Economist.

Wholesale Prices.—Journal of the Royal Statistical Society; Statist.

Retail Prices.—Abstract of Labour Statistics. Annual Abstract and Monthly Digest of Statistics.

Wage Rates.—Abstract of Labour Statistics; Farm Economist; Ministry of Agriculture and Fisheries, Report of Proceedings under the Agricultural Wages (Regulation) Act 1924 (for year ending 30th Sept. 1925); Ministry of Agriculture, Press notices.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

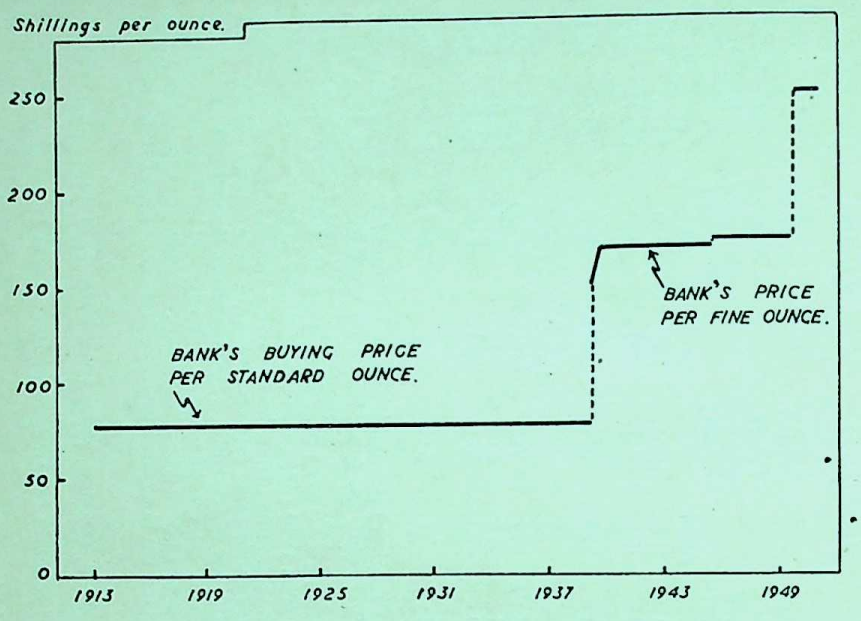


FIG. 1.—The Bank of England price of gold at certain periods.

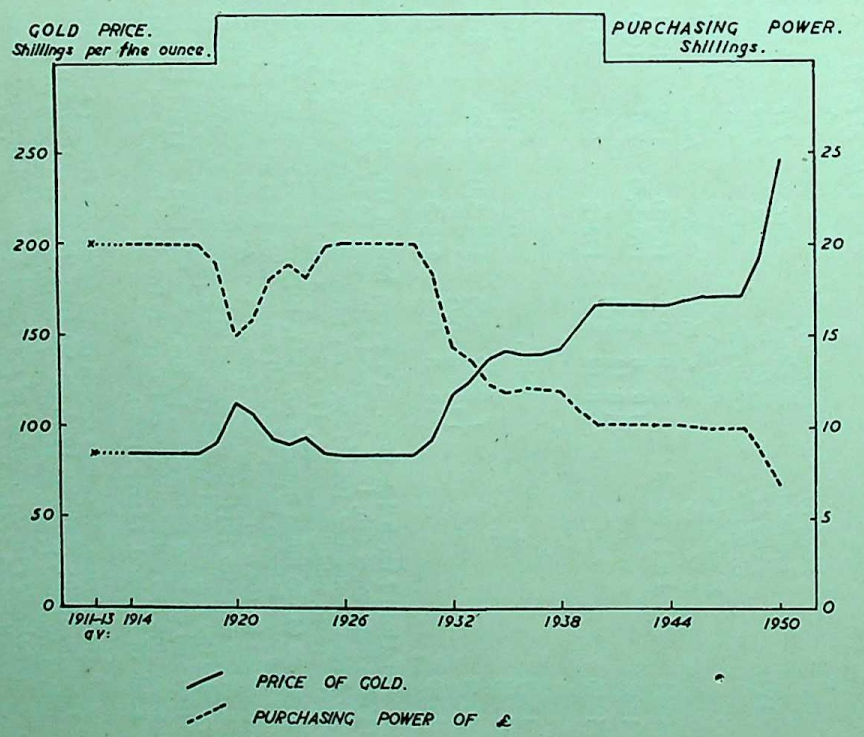


FIG. 2.—The purchasing power of £ in terms of the price of gold.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

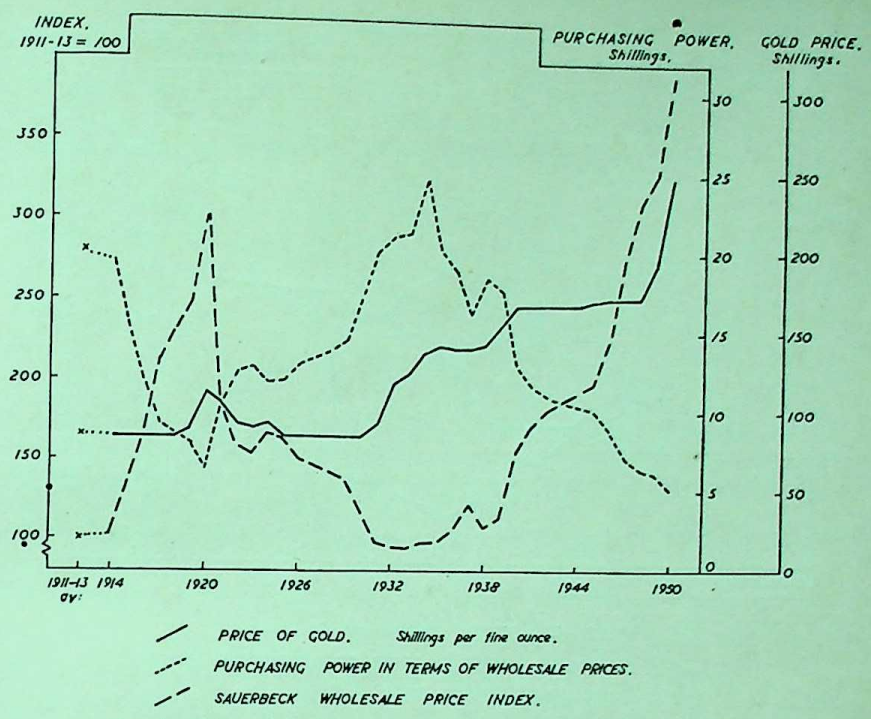


FIG. 3.—The purchasing power of £ in terms of wholesale prices.

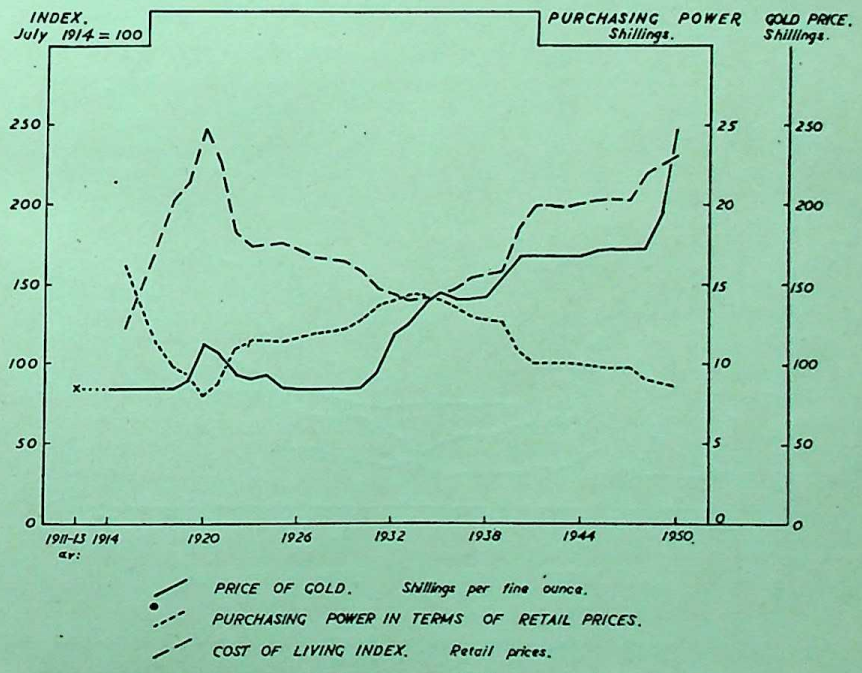


FIG. 4.—The purchasing power of £ in terms of retail prices

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

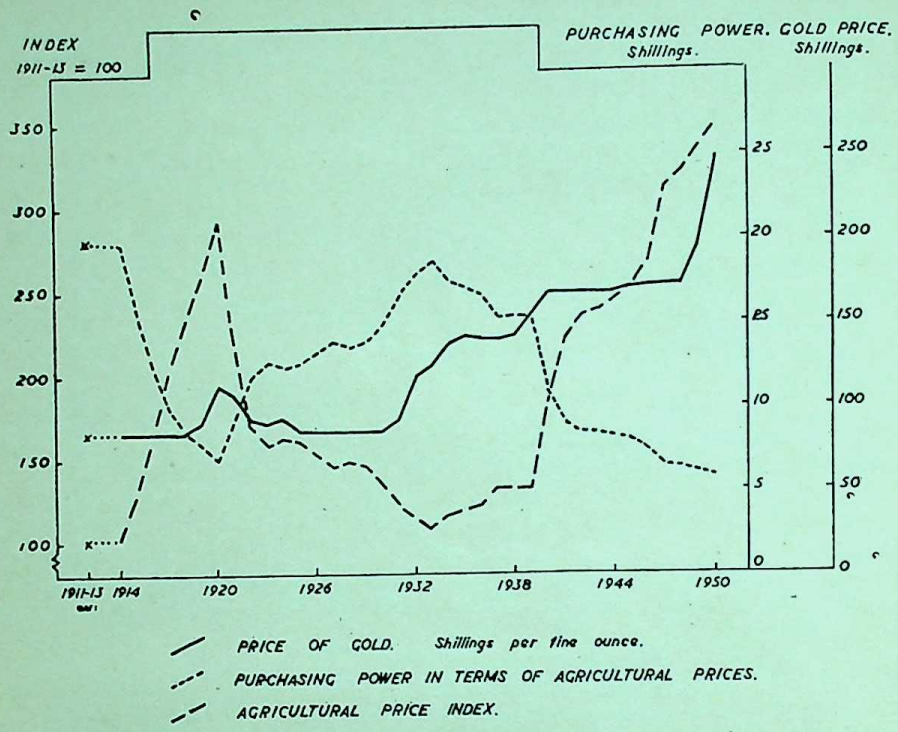


FIG. 5.—The purchasing power of £ in terms of agricultural prices.

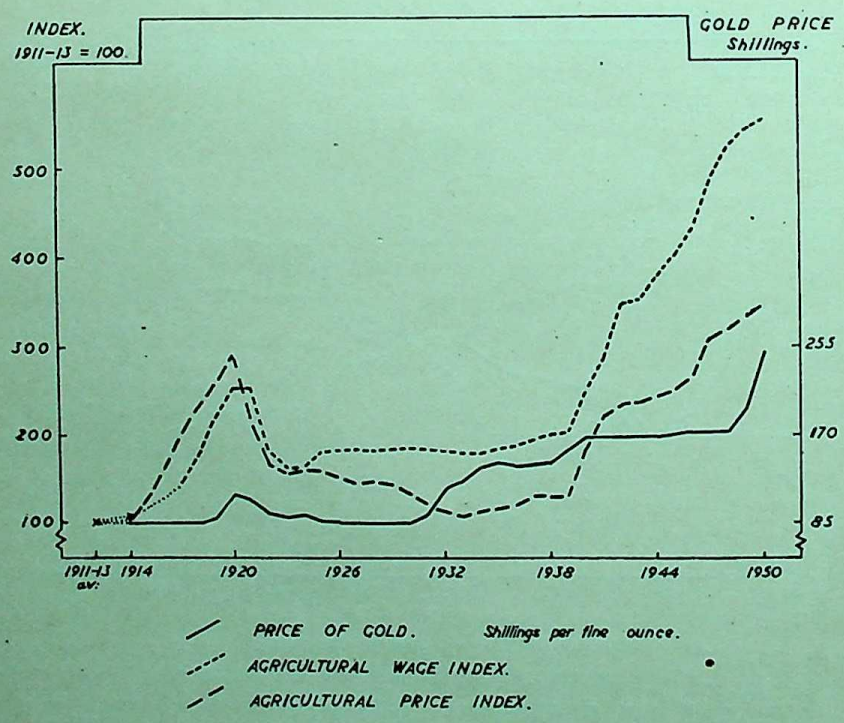


FIG. 6.—The price of gold and agricultural prices and wages.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Appendix A.

In reply to a question in the House of Commons on October 25th, 1949, the Chancellor of the Exchequer stated that, reckoned over the whole field of personal expenditure by the public, the purchasing power of the pound sterling at certain periods was approximately as follows:

Year	*Index*
1900	100
1910	95
1920	37
1930	58
1945	38
1949 (September)	31

Additional estimates of the purchasing power of the pound sterling in terms of expenditure over the whole field of consumer goods and services (based on the index published annually in the National Income White Paper) were given by the Chancellor in the House of Commons on November 8th, 1949, April 18th, 1950, and May 1st, 1951:

Taking the purchasing power of the pound sterling as 100 in 1945, the index for 1948 was 85 and that for September, 1949, 82.

Taking the purchasing power of the pound sterling as 100 in 1938, the figures for 1938–49 were as follows:

Year	*Index*	*Year*	*Index*
1938	100	1944	67
1939	97	1945	65
1940	83	1946	63
1941	75	1947	59
1942	70	1948	55
1943	68	1949	54

The purchasing power of the pound sterling in the period 1945–50 was as follows:

Year	*s.*	*d.*	*Year*	*s.*	*d.*
1945	20	0	1948	16	11
1946	19	6	1949	16	7
1947	18	3	1950	16	1

Appendix B.

The table below shows personal expenditure in the United Kingdom, 1938 and 1948, as estimated by the National Income White Paper (Treasury, 1951), together with the price index of consumer goods and services, cols. 1–5. The data of cols. 6–7 are arrived at as follows:

It is estimated for present purposes that the proportionate increase in personal expenditure shown in col. 3 is applicable also to personal expenditure after adjustment for taxes and subsidies. As a result col. 6 is obtained by multiplying the figures of col. 5 by those of col. 3 and dividing the product by 100. Data of col. 7 are then arrived at by dividing personal expenditure in 1948 after adjustment for taxes and subsidies at 1948 prices (not shown in the table below) by the corresponding data of col. 6 and multiplying the result by 100.

The data of col. 7 thus arrived at show, for instance, that food prices would have increased more in 1938–48 but for the combined effect of taxes and subsidies; on the other hand, almost all other prices, particularly those of tobacco, alcoholic drinks, household goods, clothing and entertainments would have been lower. The general price index would have been 173 and not 182 in 1948 (1938 = 100), since the expenditure on food only accounted for about 30 per cent. of total personal expenditure before adjustment for taxes and subsidies and for about 33 per cent. of total personal expenditure after adjustment for taxes and subsidies.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Personal Expenditure in the United Kingdom, 1938 and 1948

	Before Adjustment for Taxes and Subsidies				*After Adjustment for Taxes and Subsidies*		
	1938	1948 *at* 1938 *Prices*	1948 *at* 1938 *Prices as % of* 1938	*Price Index in* 1948, 1938=100	1938	1948 *at* 1938 *Prices*	*Price Index in* 1948, 1938=100
	£m. (1)	£m. (2)	(3)	(4)	£m. (5)	£m. (6)	(7)
1. Food	1,305	1,334	102	166	1,269	1,294	200
2. Alcoholic drinks	285	264	93	289	177	165	207
3. Tobacco	177	199	112	388	90	101	150
4. Rent, rates and water charges	491	534	109	112	366	399	111
5. Fuel and light	197	235	119	144	196	233	146
6. Durable household goods	234	184	79	236	231	182	191
7. Other household goods	54	50	93	166	50	47	157
8. Clothing	446	407	91	210	438	399	197
9. Books, newspapers and magazines	64	105	164	120	64	105	120
10. Private motoring	127	53	42	198	94	39	205
11. Travel	163	258	158	132	151	239	136
12. Communication services	29	43	148	133	26	38	137
13. Entertainments	64	105	164	171	52	85	141
14. Domestic service	121	44	36	216	121	44	216
15. Other services	393	488	124	154	385	477	148
16. Other goods	177	169	95	232	173	164	180
17. Income in kind of the Armed Forces	17	23	135	170	17	23	187
18. Less Foreign Tourists' expenditure in the U.K.	−43	−18	42	183	−43	−18	183
Less unallocated taxes	..	..	..	..	−99	n.a.	n.a.
19. Personal Expenditure in the U.K.	4,301	4,477	104	181	3,758	3,908	173
20. Personal Expenditure abroad	34	37	109	257	34	37	257
21. Total	4,335	4,514	104	182	3,792	3,944	173

References

BANK OF ENGLAND, *Statistical Summary.*

ENFIELD, R. R. (1924), *The Agricultural Crisis*, 1920–1923. London: Longmans, Green.

FEAVEARYEAR, A. E. (1931), *The Pound Sterling.* Oxford: Clarendon Press.

GREGORY, T. E. (1929), *Select Statutes Documents and Reports relating to British Banking*, 1832–1928. Oxford University Press. 2 vols.

LLOYDS LIST LAW REPORTS (1923). 17.

MINISTRY OF AGRICULTURE AND FISHERIES, (1925), *Report of the Committee on Stabilisation of Agricultural Prices.* (Economic Series, 2.) London: H.M.S.O.

PARLIAMENT (1914*a*), *Customs (Exportation Prohibition) Act* (4 & 5 Geo. 5, c.64). London: H.M.S.O.

—— (1914*b*), *Parliamentary Debates* . . . House of Commons [August 5th]. London: H.M.S.O.

—— (1919), *Report of the Gold Production Committee.* [Cmd. 11.] London: H.M.S.O.

—— (1939), *Defence (Finance) Regulations Amendment Order* (S.R.O. No. 1067, 1939). London: H.M.S.O.

—— (1947), *Exchange Control Act.* (10 and 11 Geo. 6. c.14). London: H.M.S.O.

Royal Mint. *Annual Report of the Deputy Master and Comptroller of the Royal Mint.* London: H.M.S.O.

SHRIGLEY, I. (1935), *The Price of Gold.* London: P. S. King.

TREASURY (1947 onwards). Bank of England: Report for the Year ended . . . February . . . London: H.M.S.O.

—— (1951), *National Income and Expenditure of the United Kingdom*, 1946 *to* 1950. [Cmd. 8203.] London: H.M.S.O.

WARREN, G. F., & PEARSON, F. A. (1935), *Gold and Prices.* London: Chapman & Hall.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

United Kingdom: Comparison of Urban and Rural Retail Prices

By J. R. Bellerby

Agricultural Economics Research Institute, Oxford

1. Principles of Measurement

The difference in the retail prices paid by farm and non-farm workers has been a necessary point for study in the Agriculture and Industry enquiry* of the Agricultural Economics Research Institute, Oxford. At the beginning of the inquiry inspection of the available figures showed that there had been a wide disparity between agricultural and industrial income per head in many countries before 1939, and it was decided to include the causes of the disparity as a chief subject of research. Since the difference in urban and rural retail prices was one of the causes, it seemed desirable to attempt some estimate of this difference in order to discover what residual margin was due to other factors.

The estimates relate purely to the difference in retail prices, not to the broader difference in the rural and urban "cost of living." Living may be less expensive in the country for reasons in no way related to the level of retail prices: there are fewer objects on which to spend money; spare time hobbies and occupations are cheaper and may sometimes yield material income; clothes last longer; "keeping up with the Joneses" calls for less outlay when all the Joneses live inexpensively. Since there was no means of measuring these factors they were deferred for separate study. The estimates of relative expense have been confined to the difference in the urban and rural retail cost of specified family budgets.

For the general needs of the inquiry it would have been enough to base the comparison on the rural budget alone. The starting-point, as noted, was the observation that farm workers received a relatively low income expressed in money; and to complete the comparison with non-farm income it would have been adequate to discover what things were comprised in a representative farm income, and what was the aggregate cost of the same things in the cities. The ratio of the urban to the rural total cost would be the adjustment factor to apply to the nominal farm income.

The procedure corresponds to that in which, if articles Q_1, Q_2 . . . are bought at prices P_1, P_2 . . . at place or date A and if the same articles have prices p_1, p_2 . . . at place or date B, the comparison of the price level at B with that of A is made by the ratio $\frac{\Sigma Qp}{\Sigma QP}$.

There is little difficulty of principle confronting the method if all the articles bought at A are available at B at a price which will not seriously alter the consumption pattern established at A. This condition was not always realized in the days of undeveloped transport; and if, for example, one staple article of farm diet is potatoes because they cost little to grow or buy locally, it is not reasonable to assume that the consumption pattern will remain unaltered in price conditions such as prevail in urban areas where potatoes have to bear relatively high costs of distribution and where calories can be obtained cheaply in sugar, flour and margarine.

Because there are difficulties in comparing dissimilar budgets, it is often contended that the ratio obtained by valuing the typical budget at A according to the prices at B and A should be

* An enquiry into certain economic and social relationships between agriculture and industry in the United Kingdom and other selected countries. The present retail price comparison owes much to the advice and help of the Statistical Services of the Ministry of Labour. For assistance in obtaining material we are under heavy obligation to them and to the Statistical Departments of the Ministry of Food and the Ministry of Fuel and Power. With regard to clothing controls and prices, the guidance from the Board of Trade was especially helpful. Where the advice of private firms and organizations has been needed assistance has been given liberally, and our collective thanks can be only a slight reflection of a very wide-spread debt.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

checked by valuing the typical budget at B by the prices at B and A. With the above notation a ratio may be based on $\frac{\Sigma qp}{\Sigma qP}$, where $q_1, q_2 \ldots$ are the articles bought at place or date B.

Whatever advantages this formula may have as a check, it is in itself less satisfactory than the first-mentioned whenever A represents either agricultural areas with B as urban areas or, in progressive economies, when A is a period much earlier in time than B. For where A represents agriculture and $q_1, q_2 \ldots$ are the items in an urban budget, many of these such as entertainment, electricity, gas and other typical town amenities will be unobtainable at any price in some rural areas, while others such as medical services and telephone calls may cost so much more in the country that expenditure on them will be drastically curtailed. These considerations relate to the newer countries primarily, though they affect most areas in some degree. They have some relevance also for a comparison of retail prices in two periods when the budget of the later period B is used as basis. Before 1914 supplies dependent on electricity or petrol formed so small a part of consumption that if B and A were on different sides of that date the typical budget at B would contain much that was unobtainable at A.

If the result derived from one formula seems moderately satisfactory and the result from the other is less so, it is by no means sure that an improvement in the more satisfactory one can be obtained by combining the two. The belief that an ideal combination can be found by striking a geometric or other mean is not supported by reason in the present instance. A ratio may be "unsatisfactory" because the budget used as basis of measurement is not fully representative of consumption at the given date or place, or because of inaccuracies arising from difficulties of price ascertainment. But unsatisfactoriness on these grounds cannot be automatically redressed or necessarily diminished by combining the ratio with another which is perhaps still more defective.

In a case where the two ratios are calculated, each ratio represents a measurement related ultimately to a separate collection of things. The two collections, or budgets, may comprise the same items, but the proportions of the items differ; that is, the "expenditure pattern" of consumers varies between the two dates or places. If, in such a case, the ratios differ, it is solely because the two collections are dissimilar in respect of their proportions or expenditure pattern. It is difficult, therefore, to give any meaning to an average of the ratios. Whereas each independent ratio represents an attempt to measure something which is clear in concept and is related to a specific collection of things, an average of the ratios measures nothing.

There is, nevertheless, one case in which a position between the two ratios will be more satisfactory than either. The reasoning proceeds from the statement, just made, that it is the difference in the expenditure pattern which is responsible for the difference in the two ratios whenever the budgets compared contain the same items. Thus if there is reason to believe that consumers at A would *change their expenditure pattern towards that prevailing at* B when confronted by the *prices* at B, then the adoption of an intermediate ratio becomes reasonable. It may be mentioned, however, that if an intermediate ratio is adopted, the measurement is no longer related solely to the consumption pattern at A: it purports to show the total cost, at B prices, of the collection of items in the proportions corresponding to the new, adjusted, consumption pattern, in relation to the total cost, at A prices, of the items in the proportions indicated by the original consumption pattern at A. The items are assumed to compose budgets giving the same aggregate utility in the two positions.

The intermediate ratio cannot logically be found by any method of averaging; ideally it should be decided according to the best judgment possible as to the nature and extent of the reaction of consumers at A, in the given conditions, when they are faced with the B pattern of prices. If judgment is difficult and it is therefore decided for expediency to adopt a midway position between the two initial ratios—as is done occasionally below—it is desirable to avoid the implication that a single ratio can represent fully the relationship of the two retail price levels. A second "adjusted" ratio might in theory be reached by expressing the total cost, at B prices, of the budget at B, in relation to the total cost, at A prices, of the items in this budget in the adjusted proportions which result from confronting consumers at B with the A pattern of prices. This ratio differs in algebraic statement* from the adjusted ratio first described. If the two adjusted ratios could be measured in practice they would not, except by chance, be equal.

* See R. G. D. Allen, "The Economic Theory of Index Numbers," *Economica*, August, 1949.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2. The Retail Price Ratio in 1937–8

A suitable starting-point for ascertaining rural and urban retail prices in the United Kingdom is the period 1937–8, when the Ministry of Labour made an inquiry into the family expenditure of over 10,000 workers. The following average expenditure per household was recorded in the *Ministry of Labour Gazette*, December, 1940, and January, 1941.

	Industrial Households	*Agricultural Households*
	s. d.	*s. d.*
Food	34 1	28 9*
Rent or purchase of dwelling, ground rent, rates, etc.	10 10	4 9
Clothing	8 1	5 3
Fuel and light	6 5	4 11
Other items	25 7	14 8
	85 0	58 4*

The two averages of household expenditure do not give an indication of relative income in agriculture and industry, since the households often included more than one wage-earner, and the junior wage-earners in agricultural households were sometimes engaged in industry; but the *distribution* of the expenditure, as shown above, is the best available evidence of the consumption pattern of agricultural and industrial families in the inter-war period. The ratio of the averages of retail prices in the areas may be obtained by, for instance, accepting as basis the consumption pattern of farm families as shown above in the distribution of their average income of 58*s.* 4*d.*, and estimating what their total expenditure would have been if the things bought with this income had been bought at urban prices. Alternatively a ratio may be calculated from the change in total cost when the things bought by industrial households with their 85*s.* are assessed at rural prices.†

Food

The price comparison for food has been based on figures from the Family Budget Inquiry of 1937–8 showing, separately for industrial and agricultural households, the average expenditure on each food and the quantity purchased per household.‡

From Table 1, col. 4, it may be seen that the prices recorded for certain foods, including imported beef, imported mutton and lamb, tea and margarine, were higher in the country than in the towns. This was probably due partly to greater distribution cost, though in some cases it may have reflected some slight difference in quality. The higher cost of these supplies was more than offset by the low prices for locally produced basic foods as milk, potatoes, eggs, bacon and other meat.

Owing to the farm households' smaller purchases, as distinct from consumption, of milk, potatoes and eggs, the additional cost to them of buying food at urban prices would have been proportionately rather less than the reduction in the cost of the industrial budget when bought

* Including allowances in kind, *i.e.*, milk and potatoes, 10¼*d.*, and other small items raising the total value to "nearly 1*s.* a week."

† "Rural prices" or "agricultural prices" means the retail levels at which agricultural households obtained their supplies regardless of the actual place of purchase.

‡ We are indebted to the Ministry of Labour for making available the quantity and expenditure figures and providing other details for improving the price comparisons.

The retail prices derived from the information relating to industrial households—Table 1, col. (2)—have been compared with average retail prices calculated from the returns which the Ministry of Labour collected in 1937–8 for purposes of the cost of living index. The prices of the two series are virtually identical in the case of bread, flour, sugar and cheese. In other cases there are differences, apparently arising either from the use of different units for price quotation or from variations in quality. The general effect of the comparison is to suggest that quantity and expenditure figures can safely be used for determining the level of urban and rural retail prices, provided that due regard is paid to the effect of quality differences in certain cases, e.g., tea and bacon.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 1

United Kingdom: Industrial and Agricultural Households: Cost of Food, 1937–8

		Retail Price			Average Household Budget					
					Industry			Agriculture		
	Unit	Industry	Agriculture	Per cent.[a] (2) of (3)	Quantity	Expenditure	Cost at Agricultural Prices	Quantity	Expenditure	Cost at Industrial Prices
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		d.	*d.*			*d.*	*d.*		*d.*	*d.*
Bread (sold by weight)	lb.	2·36	2·33	101·06	12·72	29·96	29·65	14·37	33·49	33·84
Flour	lb.	2·26	2·23	101·33	4·41	9·98	9·85	6·47	14·45	14·64
Milk fresh (incl. school milk)	pt.	3·30	2·91	113·34	11·16	36·78	32·45	8·35	24·28	27·52
Butter	lb.	16·07	15·91	100·99	1·83	29·41	29·12	1·62	25·78	26·04
Margarine	lb.	7·12	7·25	98·29	0·65	4·63	4·71	0·81	5·87	5·77
Lard	lb.	8·37	8·27	101·21	0·46	3·85	3·80	0·63	5·21	5·27
Cheese (sold by weight)	lb.	10·82	10·57	102·38	0·66	7·14	6·97	0·90	9·51	9·74
Eggs	no.	1·61	1·52	105·92	14·05	22·55	21·29	8·15	12·35	13·08
Bacon and ham	lb.	16·27	14·86	109·51	1·41	22·94	20·95	1·40	20·80	22·78
Tea	oz.	1·76	1·80	97·76	11·25	19·76	20·22	10·23	18·38	17·96
Sugar	lb.	2·62	2·61	100·21	4·81	12·58	12·55	5·92	15·45	15·48
Jams and marmalade (excl. syrup, treacle, honey)	lb.	6·19	6·01	102·94	1·01	6·25	6·07	0·90	5·41	5·57
[b]Beef and veal, home produced	lb.	12·90	12·23	105·44	1·68	21·67	20·55	1·93	23·61	24·90
,, ,, imported	lb.	10·44	11·10	94·12	0·99	10·34	10·99	0·83	9·21	8·67
[b]Mutton and lamb, home produced	lb.	12·90	12·77	101·02	0·68	8·77	8·68	0·43	5·49	5·55
,, ,, imported	lb.	10·58	11·39	92·86	0·83	8·78	9·46	0·51	5·81	5·40
[b]Pork	lb.	13·74	13·00	105·69	0·50	6·87	6·50	0·54	7·02	7·42
Potatoes	lb.	0·96	0·84	114·23	13·80	13·29	11·63	6·50	5·48	6·26
					Total:	275·55	265·44	Total:	247·60	255·88
					Ratio	103·8%		Ratio:	103·3%	

[a] From original figures before rounding.

[b] Excludes offal, sausages, tinned meat, etc.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

at rural prices. The cost ratio,* when the agricultural budget is taken as basis, is 103·3, compared with 103·8 when the industrial budget is used.

The inclusion of those allowances in kind for which comparable urban and rural retail prices have been made available—estimated at 2½ pints of milk and 3½ lb. of potatoes per agricultural household—would be equivalent to an extra expenditure of 10¼*d.* at rural prices, and 11½*d.* at urban prices, and would raise the cost ratio based on the agricultural budget to 103·7, assuming that the allowances had been valued at rural retail prices in the first place.

Concerning the foods not included in the table, it may reasonably be assumed that the pre-war prices of home-grown vegetables and fruit were lower in the country, while fish and manufactured foods were probably slightly more expensive. On balance it seems that the effect of bringing further foods into the account is to increase slightly the price disparity shown for the food group as a whole,† and it is proposed to accept 104 as the proper level of the cost ratio irrespective of whether the agricultural or the industrial budget is taken as basis.‡

Independent figures for Northern Ireland give general confirmation of those for the United Kingdom, and suggest that the relationship between Irish agricultural and industrial prices is similar in pattern to that for the whole kingdom. One minor difference is in respect of tea, the price of which is shown to be particularly high in rural areas in the north of Ireland; but the figure is thought to reflect better quality rather than a substantial price difference. If no adjustment is made for variations in quality, the general cost ratio for the food group is somewhat less favourable to agriculture in Northern Ireland, i.e., 103 per cent. compared with 104 per cent. in the United Kingdom as a whole.

Rent

Of the industrial households covered by the Ministry of Labour Inquiry 80 per cent. were renting their dwellings, and their average weekly payment for rent, rates, and water charges, after deducting any rent received for rooms sub-let, was 10*s.* 8*d.* The average number of rooms occupied by the households, including kitchens, but not sculleries, bathrooms, etc., was 3·9. Since the corresponding figures for agricultural households were 4*s.* 9*d.* and 4·0, it might seem that the gross cost of accommodation in the country was less than half that in towns. There is some question, however, whether the industrial sample in the inquiry was as representative as the agricultural sample for purposes of rent comparisons. Many households in the lowest-income group were excluded as the investigation did not cover people known to be applicants for unemployment assistance; and it is possible that refusals to co-operate came chiefly from families living in poor conditions.

The above rent comparison calls for further reservation, inasmuch as the quality both of the dwellings and of the accompanying amenities may have been lower in the country than in the towns. It is tempting to regard the rents of Council houses as a more reliable index of the relative cost of accommodation of standard quality than the figures just quoted. In the inter-war period Council houses in both town and country were built to approved specifications, and financial considerations limited the range of differences in standards. But the relative levels of urban and rural rents for these dwellings cannot be taken as representative, since Council houses were a small proportion of the whole. The rents were subsidized from rates and taxes, and there was never a free market in this type of accommodation. The cost to the tenant was not, therefore, a strict measure of the value of house-room from the point of view of either demand or cost of supply. With these reservations it may be said that in 1936 the average rental per Council dwelling, excluding rates,

* The term "cost ratio" is used to mean the cost of a given budget at industrial prices expressed as a percentage of the cost of the same budget at agricultural prices.

† The alternative to making such a guess is to exclude these items altogether; but the exclusion of an item has a statistical result which may be the reverse of what is intended: it is equivalent to assuming that the cost of the item shows the same variation as the average of all the included items.

‡ Although it is clear that over the United Kingdom as a whole the average of food prices differed little between town and country, there appear to have been appreciable local variations in some areas before the war. Professor E. P. Cathcart has published figures in a Report of the Medical Research Council entitled *A Dietary Survey in Terms of the Actual Foodstuffs Consumed*, H.M.S.O., 1936, showing, from a survey of 35 centres in Scotland, that there was a wide range of variation in the lowest prices at which certain foods were obtainable, the reason being, presumably, the differences in cost of distribution. Some country places paid prices much above average, especially for meat products and cheese. Quality differences may have been responsible for some of the variations.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

was about 7*s.* 6*d.* to 8*s.* in towns, compared with 6*s.* to 6*s.* 6*d.* in the country.* This gives a ratio of about 125 per cent., compared with 230 per cent. for dwellings included in the 1937–8 inquiry. An intermediate figure, 170 per cent., has been taken for purposes of the general retail price comparison.

Ratios for the remaining budget groups, together with an indication of sources, are given in Table 2.

TABLE 2

United Kingdom: Industrial and Agricultural Households: Relative Retail Prices, 1937–8

	Cost Ratio	Industrial Households		Agricultural Households	
		Average Expenditure	Cost at Agricultural Prices	Average Expenditure	Cost at Industrial Prices
		s. d.	s. d.	s. d.	s. d.
Food	104	34 1	32 9	28 9[a]	29 11
Rent	170	7 7	4 6	3 4	5 8
Rates[b]	100	3 3	3 3	1 5	1 5
Clothing[c]	100	8 1	8 1	5 3	5 3
Coal[d]	94	3 2	3 4	2 11	2 9
Electricity[e] Gas[f] Paraffin[h]	70	2 5[g]	3 5[g]	1 3	11
Other items[i]	100	26 5	26 5	15 5	15 5
		85 0	81 9	58 4	61 4
		Ratio: 104%		Ratio: 105%	

[a] Including allowances in kind.

[b] Ultimately the greater part of the local rate becomes the remuneration of wage earners or salaried officials employed by the Local Authority or by contractors. It is the "price" of their services, and the only justification for assuming that this price is different in town and country would be that publicly employed labour is considered to give more extensive or efficient service, in relation to the wage or salary paid, in one area than in the other. The above ratio of 100 per cent. is based on the assumption that the effect of lower wages and salaries in the country is offset by the greater distances to be covered and the more difficult conditions in which public services are rendered.

The division between rent and rates is assumed to be in the proportion 7 to 3—an approximation based on data for England and Wales in the Report of the Departmental Committee on Valuation for Rates 1939. This ratio may be too low for agriculture. In order to increase the overall cost ratio based on the agricultural budget from 105 to 106 per cent. a proportion of 8·5 to 1·5 would have to be applied to rural rents and rates.

[c] Information from clothing manufacturers and distributors indicates that in 1937–8 there was no significant difference between clothing distributors' margins, wholesale or retail, in town and country. See also note *i* below.

[d] Rural and urban coal prices have been compared by means of the quantity and expenditure figures in the report of the 1937–8 family budget inquiry, with adjustment for the price of miners' concessionary coal.

[e] *The Electricity Supply Engineering and Financial Statistics* for England and Wales and Scotland show, for large and small towns, the average charge per unit for lighting, heating and cooking for domestic purposes and for shops, offices, etc., excluding large-scale industrial use. The relative domestic cost of electricity in urban and rural areas has been estimated from an analysis of the charges in large industrial towns, and comparison with those made (*a*) in towns in rural areas, and (*b*) by electricity companies mainly serving rural areas.

[f] The comparison for gas is based on charges per unit in large towns and in relatively small towns in farming areas, as recorded in the *Gas World Year Book*, 1937–8.

[g] Gas and electricity only.

[h] The cost ratio is derived from a limited trade inquiry.

[i] The principal commodities in the "Other Items" group are drink and tobacco. Special inquiries of the trade showed that there was no appreciable difference between the rural and urban prices of these in 1937–8. Transport is next in importance. The comparison should take account not only of mileage rates, but also of the extent to which transport and travel are necessary in the process of buying and earning. Transport cost as thus conceived was found to be heaviest in the largest towns, for example, London, Birmingham and Manchester, and lowest in the small-to-medium towns of between 5,000 and 200,000 population; the cost in rural areas was judged to be intermediate between these two extremes, and a ratio of 100 per cent. was adopted.

Most of the remaining miscellaneous items such as newspapers, periodicals, postage, telephone and telegraph charges, soap and cleaning materials, furniture, hardware, utensils, medical and holiday expenses either cost the same in the two areas or may be said to be equal in price if the cost of transport and travel is considered separately.

* *Rents of Houses and Flats owned by Local Authorities*, Cmd. 5527, p. 4.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

General Cost Ratio

The combined result for all groups may be expressed in relation to the total cost, 58*s.* 4*d.*, of the typical budget of agricultural households. If a budget equivalent in composition and quality to that which they obtained with this outlay had been bought at urban prices the cost would have been 61*s.* 4*d.*, implying an urban-rural cost ratio of 105 per cent. The reduction in the expenditure of industrial households through purchase at agricultural prices, would have been from 85*s.* 0*d.* to 81*s.* 9*d.*, the cost ratio being 104 per cent.

It may be useful in conclusion to consider the ratios in Table 2 from the point of view of their varying degrees of reliability. The comparison in the case of food seems reasonably exact apart from the difficulty, already mentioned, of adjusting prices for differences in quality. Such differences do not seriously affect the main conclusion regarding the disparity in the average retail prices of food in the two areas. This was due principally to the low prices of milk, potatoes, and home-produced meat and eggs in country districts, and the local supplies of these were not lower in quality. The disparity has been given as 4 per cent. It is not impossible that it was as much as 6 per cent., or as low as 2 per cent., for no exact price information is available for fresh vegetables and a considerable range of manufactured foods. From a review of individual items 4 per cent. seems much more probable than either of the extremes mentioned.

The comparison for coal has been made in the same manner as that for food, and the degree of reliability is about the same.

Many articles are bought in towns by both rural and urban customers, and the price of these must be shown as exactly equal for both classes, if the cost of travel and delivery is brought into the reckoning elsewhere.

The above commodities, together with drink, tobacco, and other price-maintained articles, and public supplies and services for which there are uniform national charges, cover about 80 per cent. of the agricultural household's budget.

The least secure figures are for rent (with a weight of 6–9 per cent.) and light and power (2–3 per cent.); and some uncertainty attaches to the suggestion that the transport element in the cost of earning and buying is about the same for rural areas as for large and small towns combined. The treatment of rates (2–4 per cent.) is somewhat arbitrary.

If there is uncertainty in our conclusion that 104–5 per cent.* represents the ratio of urban to rural retail prices in 1937–8, the principal reason is that the comparison is between two collections of items some of which are unlike in quality, and that any adjustment for quality inevitably rests on opinion.

3. Other Evidence of the Difference in Retail Prices

Since arbitration and conciliation councils are directly concerned with regional differences in retail prices, it will be relevant to note some of their conclusions as to the margins between urban and rural price levels in recent times. In the national decisions of certain industries retail price differences are specifically taken into account, but these are by no means the only considerations affecting regional rates. There is a traditional element in every award or agreement. At the time when national organization superseded local wage-fixing arrangements, the local scales then operating formed the point of departure for the new agreements; and in some cases it may be said that the former differences in rates still influence current wage decisions. The more important factors which caused the initial differences are in any event still taken into consideration. In the building industry, for instance, although retail price differences are the main concern in regional wage-fixing, account is taken also of the rates paid in competing local industries, together with the state of demand and employment in the area. In road haulage high rates are paid in large towns and ports because the character of the traffic and loads calls for special skill and endurance. Special influences such as these may have a cumulative effect in determining wage differences in different areas. It should be added that in most cases wage decisions are reached by a process of negotiation and are not based on exact assessments.

The widest regional differences revealed by our inquiries for 1947, if London be excluded, are in the retail bespoke tailoring trade in Scotland, where the rate for experienced male workers in areas 1, 2 and 3, comprising the largest towns, was 20 per cent. above the rate in a residual area 5

* Or possibly 106 per cent.—see Table 2, footnote *b*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

in 1947. The figures for the same trade in England and Wales show a 7 per cent. difference in the time rates of certain male classes in Area A and Area C, which distinguish large towns and a residual area respectively. The following list gives further samples of differential rates, showing as far as possible two manual trades in each industry, one with the largest regional difference in wages, the other with the smallest appreciable difference. The London rates are as a rule omitted owing to the difficulty in weighting them, but their inclusion in urban areas would substantially increase the difference shown in some cases.

TABLE 3

Percentage Difference in Wage Rates in Urban and Rural Areas, 1947

	% *Urban above Rural Rates*
Printing	
Assistants in newspaper offices, class 3 (evening newspapers)	10·22
Bookbinders (in Scotland)	2·71
Milk Distribution	
Sterilizers (over 21)	8·28
Roundsmen (over 21)	8·13
Flour Milling	
Labourers	7·95
First rollerman (grade 1 mills)	6·73
Building	
Craftsmen	5·26
Labourers	4·35
Baking	
"Other workers"	4·88
First hands	4·21
Road Haulage	
Drivers of vehicles, 2–3½ tons	4·37
Removal packers	2·29
Home Grown Timber	
Skilled sawyers	3·77
Sawyers	2·08
Retail Distribution	
Warehouse staff (food trade)	3·75
Warehouse staff (retail grocery, Scotland)	2·44
Gas Supply Maintenance	
Drillers	3·70
Blacksmiths	3·13
Retail Co-operative	
Assistant milk roundsmen, 21 and over	3·17
Porters (over 23)	1·07
Electricity Supply	
Coal weighers	3·16
Blacksmiths	2·56
Railway Workshops	
Turners—wheel	2·63
Boiler attendants	0·52
County Council Roadmen	2·22
Land Drainage	2·22
Railway Service	
Goods porters	1·09
Signalmen, class 1	0·87

Source: Ministry of Labour, *Time Rates of Wages and Hours of Labour*, September 1st, 1947. Rates for supervisory and non-manual positions are excluded.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

4. Past and Future Trends in the Ratio

A broad estimate of the ratio of urban to rural retail prices in 1904 may be made from official sources* relating to the composition of workers' family budgets and to the cost of food, housing and coal. Expenditure on these was a high proportion of the total family outlay at the beginning of the century; and as regards the remaining items, which in their final state were almost entirely industrial—for example, drink, tobacco goods, and clothing—it may reasonably be judged that the average price differed little between town and country. The rural price of clothing may be considered to have been somewhat above the urban price in view of the relatively high cost of travel or transport in rural areas.

The cost ratio for food in 1904 was found to be 112 or 117, according to whether the point of departure was the urban or the rural budget. In any final estimate it would be desirable to adjust downwards the ratio of 117 in view of the certainty that the cheapest foods in the rural areas would have been bought in much smaller quantities if it had been necessary to pay urban prices. Moreover, these goods were overweighted in the rural budget owing to the inclusion of produce from workers' gardens and allotments—there being no data for adjusting the primary material.

As regards rent, the evidence suggests that the position was similar to that prevailing in 1937–8. The cost ratio for coal, judged from records of prices in the *Sixteenth Abstract of Labour Statistics*, was more unfavourable to country districts than in 1937–8, presumably owing to changes in the efficiency of haulage in rural areas. Despite the narrowing of the price margin for coal, however, that for fuel, power and light as a group widened somewhat between 1904 and 1937–8 as a result of the increasing use of gas and electricity, which are relatively expensive in the country.

The findings for the various budget groups are given in Table 4 in relation to family budgets which differ slightly from the official data by reason of their including drink and tobacco.

Table 4

Retail Price Comparison, 1904

	Industrial Household		*Agricultural Household*	
	Expenditure	*Cost at Rural Prices*	*Expenditure*	*Cost at Urban Prices*
	s. d.	*s. d.*	*s. d.*	*s. d.*
Food	14 0	12 6	13 6	15 10
Rent and rates (*a*)	4 0	2 8	1 9	2 10
Clothing	4 0	4 3	3 0	2 10
Fuel and light	2 0	2 3	1 9	1 7
Other items (incl. drink and tobacco)	4 0	4 1	2 0	2 0
	28 0	25 9	22 0	25 1
	Ratio: 109		Ratio: 114	

(*a*) A ratio of 170 per cent. has been applied to rent, and 100 per cent. to rates. The division between rent and rates has been judged from data in the B.o.T. Mem., Cd.2337, 1904, p. 50.

The overall cost ratio is 114 per cent. when the rural budget is used. For the reasons mentioned this would be adjusted towards the ratio of 109 based on the industrial budget when used for assisting comparisons of real income. An intermediate figure of 111 or 112 per cent. would be comparable with the ratio of 104 or 105 per cent. for 1937–8.

In brief, the chief feature of the change in the margin between urban and rural prices from 1904 to 1937–8 was the movement towards equality in food prices associated with a decline in the proportion of expenditure on food. Among the influences tending to produce equality in food prices were the revolution in road transport and the increasing dependence of both town and country

* Board of Trade, *Memoranda on British and Foreign Trade and Industrial Conditions*, Cd. 1761 (1903), Cd. 2337 (1904); Report by Wilson Fox on *Wages, Earnings and Conditions of Employment of Agricultural Labourers in the United Kingdom*, Cd. 2376 (1913); *The Financial Results of the Occupation of Agricultural Land and the Cost of Living of Rural Workers*, Cmd. 76 (1919); *Sixteenth Abstract of Labour Statistics*. See also Porter, *The Progress of the Nation*, p. 435.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

on foods which have been processed in towns, or on imported foods. The improvement in transport has cut down the cost of distribution, while greater dependence on urban and overseas supplies has caused an increasing share of the distribution cost to be borne by country customers.

A further development tending to move the price ratio in favour of industry has been the increased rural use of gas and electricity supplied by pipe or cable from towns.

THE FUTURE

The problem of assessing the relative price position since 1939 is complicated by changes in the extent of Government intervention. About twenty months after the outbreak of the late war comprehensive control of prices was established with a view to preventing inflation, and the continuance of the policy after the war materially affected the price position in 1947. A calculation made in that year, when the new "interim" index was introduced, showed that approximately 70 per cent. of all the items in the index, by allocated weight, were controlled by public authorites directly or through agreements or legislation. A further substantial proportion, including much of the drink and tobacco group, was under some form of private regulation tending to preserve uniformity of prices. This widespread public and private control did not remove all price differences between town and country, but it produced almost complete uniformity in the case of some essentials.

As regards food, the 4 per cent. difference between urban and rural retail prices shown in the returns of the 1937–8 inquiry was virtually eliminated in the latter half of the war. Although theoretically the prices fixed were only ceilings, they became the ruling prices everywhere; it was a seller's market, and retailers had no incentive to reduce their margins. When certain fresh vegetables and fruit were decontrolled after the war there was some difference in the rural and urban prices of these, a condition affecting 1947 to some extent; but the influence on the general retail price position was not significant. A calculation made in 1950 from National Food Survey returns showed that the difference in the rural and urban cost of the rural food budget was less than 1 per cent.

The only important case of a trend towards greater disparity appears to have been in rents. The concentration of air-raid damage on the large manufacturing and seaport towns, followed by re-building at heavy cost, has led to an increase in the proportion of highly rented urban dwellings. Despite the statutory controls over the rents of undamaged houses the average for all types of urban dwellings has probably risen appreciably.

Were it not for the continuing disparity of rents the general retail price position in the 1950's would already be unfavourable to the rural areas. As regards the future, little change may be expected in the rent ratio for some years, but ultimately two influences may affect the country districts adversely: the higher level of rural building costs; and the growing demand for country dwellings by people taking advantage of the increased speed and efficiency of transport.

A reasonable forecast for a period of not less than ten years would be that the ratio will continue to fluctuate between about 102 and 105 per cent. according to the variations in Government control, and that in due course the ratio will decline to 100 or possibly less.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

Food Statistics

By W. D. Stedman Jones

Contents

	PAGE
I. *Introduction*	57
II. *Commodity Statistics*	
A. Definitions	58
B. Grain	58
C. Sugar	59
D. Meat	63
E. Bacon and Ham	64
F. Milk and Milk Products	65
G. Potatoes	66
H. Fresh, Frozen and Cured Fish	67
I. Oils and Fats	68
J. Other (Processed and Manufactured) Foods	70
III. *Food Consumption and Production*	71
IV. *National Expenditure on Food*	75
Appendix	79
Bibliography	82
	83

I. *Introduction*

Food statistics fall naturally into three compartments: (*a*) data on supplies available, whether from indigenous production or imports; (*b*) disposal of the available supplies into human consumption, animal feed, non-feed uses and exports ; (*c*) data on the place of food in the national economy.

Estimates of the production of foodstuffs and feeding-stuffs at home were prepared before the war by the Agricultural Departments. The wartime controls necessarily produced a wealth of material on foodstuffs, which in turn provided the basis on which some of the gaps in our knowledge of the immediate pre-war period could be filled in. These controls were designed to provide the data on supplies for regulating food consumption and distribution, and must therefore at many points touch upon questions of the production of foodstuffs.

Certain agencies—mainly marketing organizations—were in existence before the war, and their operations, generally of a regulatory character, covered the same ground as the controls operated by the Ministry of Food. The most important of these were:

1. The Wheat Commission.
2. The British Sugar Corporation.
3. The Milk Marketing Board.
4. Bacon Marketing Board.
5. Livestock Commission.
6. Potato Marketing Board.

Some or all of the functions of these bodies were taken over by the Ministry of Food at the outbreak of war, and statistical information was enlarged as befitted the necessity to watch the overall food position of the nation.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

II. *Commodity Statistics*

A. *Definitions*

The sections dealing with the main food commodities attempt to deal with the nature and amount of the data available on the pre-war period. The war-time and post-war data are then discussed. Inevitably much of the comment on the pre-war figures relates to deficiencies, some of which became apparent only when fuller information became available under war-time controls.

The operation of Ministry of Food controls threw up statistical information in greater volume and detail, and the main results of these operations as far as statistics of supplies and consumption are concerned are published in the *Monthly Digest of Statistics* and the *Annual Abstract of Statistics*. The notes given in those publications together with the definitions and explanations (published separately) give much guidance on points of detail. The present section aims at giving a broad description, applicable more or less generally to all commodities, of the way in which the figures are obtained and their meaning.

The figures appearing in the *Monthly Digest* and in the *Annual Abstract* may be divided into three main groups:

1. Agricultural production—that is, movements of crops off farms and purchase of livestock for slaughter.
2. Production and processing of manufacturing foodstuffs.
3. Consumption.

In addition to these three main groups, the *Annual Abstract* contains a certain amount of statistical information relating to the structure of the food distributive trades, which has been obtained through the operation of the Ministry's administrative controls. Thus, there are tables showing changes in the number of retail outlets for food and, for certain trades, the numbers of shops of varying size (e.g., according to the consumer registrations held) and the proportions of trade handled by multiple, co-operative and independent retailers. Statistics are also given of the different types of catering establishment, commercial and non-commercial, and the meals served by them.

There are certain points which call for comment before discussing these three groups.

(i) *The statistical calendar.*—Figures in the *Annual Abstract* refer to calendar years before 1940, but from then onwards to statistical years in which the Ministry of Food worked from the beginning of 1940. The standard statistical year consists of four quarters of 13 weeks, the months in each quarter containing 5, 4 and 4 weeks respectively. This enables comparisons to be made more readily between one month and another, and avoids the effects of an odd number of days in each month. It also accords with the administrative necessity of assessing stocks at not less than weekly intervals during the war and post-war years.

Accumulated lags between statistical and calendar years make it necessary periodically to have 53-week years. This is done by having five weeks in December instead of the usual four. This step was taken in respect of 1943 and 1948. The *Monthly Digest* shows average weekly figures for each month based on the statistical calendar. The original statistics are usually collected in four- or eight-week periods because allocations of rationed or controlled foods are made to the trade at these intervals. For some commodities statistics are quoted according to the four- and five-week statistical month described above, but for fresh milk, condensed milk, milk powder, cocoa and fish, statistics are collected for calendar month periods.

(ii) *Imports.*—From the start of the war it was found to be impossible for the Ministry of Food to work on the basis of taking into stocks goods as they were entered into the Trade and Navigation Accounts. The term "imports" refers to the entry of goods on Customs records on which the Trade and Navigation Accounts are based. As Customs declarations may be made at any time up to 14 working days after the ship's arrival, or even before its arrival, they were found to be unsuitable for Ministry of Food purposes. From the beginning of the war all imports of foodstuffs were bought either by or under the authority of the Ministry of Food, and as weekly stock figures were required for administrative control, and the arrival of a cargo was for many commodities the point at which the Ministry's control started, the Ministry of Food was compelled to work on its own "arrivals" basis for food imported into the United Kingdom. The date of arrival is taken as the day on which the vessel ties up at the port of discharge in the United Kingdom,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and incoming cargoes on Ministry account are taken into stock upon the arrival of the ship. During the post-war years a substantial number of foodstuffs have been released from Ministry control and for these Customs records of imports must be used.

Agricultural production.—There is close consultation between the Ministry of Food and the Ministry of Agriculture on statistics relating to home production of crops and livestock. Records of movements off farms (and for most commodities this is the Ministry of Food's definition of production) are obtained by the Ministry of Food, and these figures are related to the total crop estimates made by the Ministry of Agriculture from acreage returns and estimated average yields. Similarly, while the Ministry of Agriculture is responsible for estimating the numbers of livestock, the Ministry of Food's records begin when they are entered at collecting centres for slaughter. There is, of course, joint consultation between the two Departments on the marketings of livestock and livestock products. For example, in the case of shell eggs, commercial production through the country's packing stations is fully controlled by the Ministry of Food. The total supplies, including the production by domestic keepers, are estimated in collaboration with the Ministry of Agriculture. Milk, however, is in a different category. Sales through Milk Marketing Boards are taken as the measure of production.

Production and processing.—Statistics of factory production or processing are mainly derived from administrative controls. In some cases—for example, seed crushing and the manufacture of margarine and cooking fat—the Ministry of Food owns all the material involved at all stages of processing until it leaves the margarine or cooking-fat factory as a finished product. In other cases, such as sugar, there is full control, although the Ministry does not retain ownership after arrival. For some commodities—for example, butter and bacon—there is a small amount of self-supplier production, which can be estimated, but the Ministry's concern is mainly with commercial production, which is subject to controlled distribution and so made available for general distribution on the ration. Of the items for which production statistics are shown in the *Monthly Digest* there is full Ministry control over the production of meat, margarine, cooking fat, processing of oilseeds into crude vegetable oils and oilcakes, bacon, butter, ration cheese, home-grown sugar, wheat and flour milling—subject to the observation on self-supplier production in some cases.

Consumption.—Since changes in stocks are of great importance in arriving at figures of consumption, a note on this subject at this point is necessary. In general total stocks include all stocks in ships which have arrived at ports, stocks lying in port warehouses, in transit in the United Kingdom, at processors' and manufacturers' premises, and those stocks held by wholesalers and merchants. They do not include any estimates of retailers' stocks. Even under full control there are differences between one commodity and another, and total stocks of particular commodities do not always conform to a common pattern. Variations from the general rule are shown by sugar and oils and fats, both of which are distributed in a complex chain of producers and manufacturers, who use them as ingredients in finished products. Total stocks of sugar include estimates of sugar held by preserve manufacturers, but oils and fats stocks have never included stocks held by soap makers, biscuit makers, etc. For such commodities Ministry allocation to manufacturers afforded sufficient administrative control with regular inquiries into the stock holdings.

Total stocks can usually be divided into two categories : (i) those owned or controlled by the Ministry and described as "bulk" stocks ; (ii) those owned by wholesalers, merchants, processing factories, etc., and described as " supplementary" stocks.

For all major commodities bulk stocks are the most important element in total stocks and are accurately known while control lasts. Supplementary stocks are largely estimated, although in some cases, for example primary wholesalers, returns are made regularly to the Ministry. Wholesalers' stocks of the main foodstuffs were estimated by means of a periodic sample survey during the war, but this was discontinued in 1947. The freeing of commodities from control has resulted in the shrinkage of the field for which the Ministry obtains actual stock information.

B. *Grain.*

Before the war no official estimates of the utilization of the home-grown grain crops were published. *Agricultural Statistics*, Part I, published by Ministry of Agriculture and Fisheries, gave estimates of home production, but the only official information on utilization appeared in the Census of Production Reports. Thus, the 1935 Census showed how much home-grown

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

wheat, barley and oats were used in 1934 and 1935, separately for England and Wales, Scotland and Northern Ireland, by firms in the grain-milling industry employing more than 10 persons and the proportion of the home-grown wheat crop used. The 1935 Census showed also how much home-grown barley was used in the production of malt. This information was obviously only of limited value, and did not enable the inquirer to make anything like a precise estimate of the utilization of home crops. The information in Agricultural Statistics and the Census of Production was supplemented from two other sources : (*a*) Information collected by the Ministry of Agriculture and Fisheries under the Corn Returns Acts; every sale of home-grown grain had to be included in a return made by the merchant, brewer, miller or other person concerned in the transaction. These returns were, however, of only limited value in assessing the proportion of the crop actually sold off farms because they did not purport to include sales effected outside the statutory towns, nor did they differentiate between various qualities of grain sold or the nature of the transaction. They did, however, provide an indication of the rate of marketing and of price changes throughout the season. (*b*) From 1932 until the suspension of the Wheat Acts in 1940 Wheat Commission Receipt Certificates issued by "authorized merchants" in respect of all sales of home-grown wheat for which application was made for deficiency payments under the Wheat Act, 1932. These certificates showed among other things the quantity sold and the price paid "at farm". This enabled the Wheat Commission to calculate the total quantities sold in each season and the average price paid. Apart from seed no attempt was made, however, to distinguish between grades of wheat sold or the end use, the only requirement as to quality being that the wheat should comply with the statutory definition of "millable". In order to qualify for deficiency payments the wheat had to be the subject of an out-and-out sale by the grower, and any wheat sold on condition or on the understanding that it should be returned to the grower after a certificate had been issued by the authorized merchant was not eligible for deficiency payments. Consequently in order to qualify for deficiency payment a higher proportion of the U.K. wheat crop was sold after the introduction of the Wheat Act than previously, and it may be concluded that the bulk of the millable wheat used by farmers for stock feed had been bought after a previous sale to an authorized merchant or by another farmer. This point should be borne in mind when attempting to draw any comparisons with other figures.

For home-grown barley the Brewers' Society published in the *Brewers' Almanack* figures relating to the quantities of home-grown barley bought by brewers or used in the production of malt bought by them. These figures relate to the years 1933 to 1939, and were compiled from returns made by firms producing more than 95 per cent. of the barrellage.

With the introduction of controls certain buyers were licensed to buy home-grown cereals, and the quantities bought by them of home-grown wheat, barley, oats, dredge corn and rye have been recorded month by month (since 1947 they have been published in the Ministry of Food Bulletin). Until June, 1950, the quantities of home-grown feeding beans and peas were also known, but with the decontrol of pulses the information provided by the trade has been incomplete.

The figures for approved buyers' receipts do not distinguish between end-use of the grain as they include all grain received by the approved buyers. The special value of the approved buyers' returns lies in the prompt information disclosed concerning the aggregate movements off farms. The restrictions imposed on the use of grain for various purposes, including the food manufacturing industries, have been instrumental in providing fairly complete information on the quantities of home-grown grains received by manufacturers as distinct from buyers, and such returns have been received from flour millers, oatmeal millers, and barley manufacturers, brewers and maltsters, distillers, starch and glucose manufacturers and cereal breakfast food manufacturers. Some of this information has been published in the *Monthly Digest of Statistics* under the heading of "Movement off Farms" and "Barley for Brewing and Food". Annual total figures have been incorporated in the tables of utilization in *Agricultural Statistics, 1945, Part II.* Taken together, the figures for approved buyers' receipts and movements off farms, with the utilization of crops data in *Agricultural Statistics*, give a fairly comprehensive picture of the extent to which home-grown crops are utilized for food and feed. The principal defect in the utilization tables given in *Agricultural Statistics* is that the whole of the error that there may be in the official estimate of production is thrown on to the residual item, that is, use for animal food.

The Ministry's controls over imports, storage and distribution of cereals are exercised through

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Port Area Grain Committees. These Committees are responsible for Customs entries in respect of commodities under their control, so that while Ministry of Food "arrivals" and the corresponding figures in the Trade and Navigation Accounts do not coincide, the differences over a period are negligible. Some cereals and cereal products may now be imported under open general licence from some countries, but apart from pulses the commodities concerned are not important.

Attempts to reconcile U.K. statistics of imports of major commodities, such as wheat and flour, with the corresponding export statistics of the supplying countries with a view of determining, for instance, the origin and types of wheat and flour imported into the United Kingdom have not met with complete success, despite the advantage of the additional information provided by the concentration of importing in Ministry hands. Trade and Navigation Account figures relate to the country of consignment, and in recent years these usually coincided with countries of origin, whereas substantial exports of wheat and flour, especially from North America, before the war which never reached the United Kingdom appeared in the export statistics as destined "for U.K. or orders". The main usefulness of the information derived from Ministry of Food controls lies mainly in the data on end-uses and the following notes indicate what these are :

Grain milling.—The definition of the grain milling trade in the Census of Production, 1935, is ". . . firms that were engaged wholly or mainly in the manufacture of flour and meal and in the preparation of animal and poultry feeding-stuffs of which grain was the principal ingredient". In 1924 the gross output of the small firms making returns was negligible in the case of wheat products, but of some significance in the case of oats, barley and some other products. With a tendency to greater concentration in production in the flour-milling trade it is doubtful whether any serious error results from ignoring altogether the output of the small firms excluded from the 1935 census, but the figures for other sections of the grain-milling trade in that census should be regarded as giving only an incomplete picture, particularly in the case of oats and barley. Subject to this general qualification, the 1935 census gave a useful analysis of production of the various main types of cereal products for human and animal consumption, and for the main commodities a further subdivision between port and inland mills. The section on materials used shows separately the quantities of home-grown and imported grain used, but this was of limited value except for wheat, for which commodity a special table was included showing the proportion of the home-grown crop and the imported supplies used by the grain-milling industry.

The deficiency payments paid to wheat growers by the Wheat Commission were financed by a levy on flour imported into or delivered by millers in the United Kingdom. From returns received from flour millers the Wheat Commission maintained a detailed record of flour delivered for home consumption and for export or use as ships' stores. With the aid of this information and the data on flour and by-products produced provided by the Census of Production it was possible to estimate year by year the total supplies of wheat-grain and wheat products, and to estimate the quantities of wheat and wheat products used for animal feeding purposes (see report of the Wheat Commission, Economic Series No. 45).

Since controls were introduced flour millers' weekly returns show stocks, receipts and usage of the various types of imported and of home-grown wheat and stocks, production and deliveries of the various types of flour and by-products. Total figures for the United Kingdom for wheat milled, flour and offals produced are published in the *Monthly Digest of Statistics* ; from the figures of millers' receipts of home-grown wheat it is possible to estimate the proportion of home-grown wheat used in millers' grists over the year. With the aid of the grist instructions published from time to time in the trade papers it is also possible to estimate the rate of usage of home-grown wheat from month to month, although such an estimate can only be approximate because different instructions apply to the production of speciality flours, and some home-grown wheat is used in the manufacture of wheat-based cereal breakfast foods. The figures also disclose the effective rate of extraction of flour from wheat in the milling process. The quantity of wheat milled excludes screenings, etc., and it should be mentioned that in 1943 and 1944 the quantities of flour and offals produced included small quantities produced from barley, oats and rye introduced into the grists in order to economize in the use of wheat. Figures for recent years show that the quantities of flour and offals produced together amount to less than the quantity of wheat milled, as a result of moisture and other losses in the milling process. Pre-war data available in the Census of Production showed a net gain in that the aggregate weight of product produced exceeded that of the wheat milled. This difference between the pre-war and later figures may result from differences

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

in the bases of the statistics, but it is possible also that the much higher proportion of home-grown wheat used in millers' grists during and since the war has also affected the relationship between quantities of wheat milled and the end-products.

With the exception of a short period after the end of the war, the bulk of imported flour has for many years been mixed with home-produced flour and distributed as "national" flour. This explains why the figures shown in the *Digest* for the flour produced are invariably lower than the total disposals shown in the consumption tables. The average proportion of imported flour over a period may be calculated by reference to the quantity of flour imported and the quantity produced in the United Kingdom. The published figures show that the quantity of wheat used by the flour-milling industry at the present time is not very different from the quantities used before the war. The higher rates of extraction now prevailing are offset by the higher *per caput* consumption of flour and flour products. The production of milling offals for animal feeding purposes is, however, still well below the pre-war level. It is evident from the statistics that the United Kingdom flour-milling industry is not now working to full capacity.

The oatmeal-milling industry was brought under control in 1941, and information is available showing the quantities of oats received, milled and held in stock as well as the production, deliveries and stocks of oat products. Tables showing oats milled and products produced are published in the *Monthly Digest of Statistics*. These figures exclude any quantities subject to further processing before delivery outside the industry. Figures for the direct human consumption of barley, that is, quantities of barley received and used and of the products produced and delivered, were collected until the industry was decontrolled early in 1950. The *Digest* does not give figures for production or deliveries, but the quantities of barley received by the industry appear in *Agricultural Statistics, Pt. II.* Since decontrol these figures are estimates. Returns for cereal breakfast foods (other than oat products) covering raw materials received, used and held in stock and the quantities of product produced and delivered were required until the industry was decontrolled in 1949. The cereals used as raw materials include wheat, flour, bran, maize, barley, rice. There is now no restriction on the use of grain, and since allocations of sugar are still made the returns of stocks, receipts and usage and the production of cereal breakfast foods are still obtained. The total figure for U.K. production is given in the *Digest*.

Bread, cakes, pastries, etc.—According to the definition in the Census of Production, 1935, this trade comprises firms engaged wholly or partly in the baking of bread, cakes, pastries, etc., and the manufacture of ice-cream. The 1935 report gives an analysis of the value of the total production of bread and of cakes, pastries, etc., with separate figures for large and small firms. Figures are also given for bread only. A feature of this trade is the relatively large proportion of total production made by small firms. A representative sample of such firms was taken in 1935 and, as might be expected, the principal item of production was bread, both as to quantity and value, but cakes, pastries, etc., accounted for more than one-third of the total value. Less important products included self-raising flour, ice-cream, biscuits, meat pies. Of the total quantity of wheaten flour used by the trade, the proportion used in bread-making can be estimated fairly closely, but it is not possible to make anything like an accurate analysis of the quantities of flour used in other kinds of products. The Census report included some data concerning the price of bread sold in relation to the cost of flour. A more detailed analysis of this subject is available in the report of the Wheat Commission (Economic Series, No. 45).

Under the arrangements for the control of flour milling and the maximum prices for bread, bakers who wished to claim the bread subsidy on bread sold by them were required to make a return every 8 weeks. This return gives the bread sales and flour used. These figures are not published, but are used in arriving at the figures for flour disposals which appear in the consumption tables and the *Digest*. No detailed measurement of the production of cake and flour confectionery has been made, but the Ministry has relied upon its controls over the supply and distribution of essential ingredients, and for some years the Ministry has conducted a sample inquiry designed to show the quantities of the principal ingredients used and a simple classification of products. In 1949 the sample was revised and a selection made from among the 30,000 or so firms who receive allocations of fats for the production of cake and flour confectionery. This sample is taken quarterly, and provides a useful indication of the total volume of production of defined categories of cake and flour confectionery and of the quantity of wheaten flour used in its manufacture.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In the case of biscuits the Ministry of Food has received detailed information relating to the stock, production and despatch of the various kinds of biscuits and of the quantity of wheaten flour used in their manufacture.* Total production figures for the United Kingdom are given in the *Digest*.

Cattle, dog and poultry food trades.—The definition of these trades is that they comprise firms engaged wholly or mainly in the manufacture of cattle, dog and poultry food except cereal feeding-stuffs produced by grain-milling firms. The value of the gross output of the small firms in this trade was, of course, excluded from the 1935 census, but amounted to about 35 per cent. of the total in 1924. The principal items in the output of this trade were compound cake and meal for poultry foods, fish meal, meat meal, dog biscuits and hound meal. Owing to the exclusion of firms which used grain as the principal ingredient of their products and of firms producing oilseed cake in the process of seed crushing, the output of the trade represented only part of the total supply of animal feeding-stuffs processed in the United Kingdom before the war.

The prices of feeding-stuffs were first controlled in 1939 and the animal feeding-stuffs rationing scheme was introduced in 1941. The scheme involves the issue of ration documents by the local committees appointed by the Ministry of Agriculture in accordance with the ration scales laid down by that Ministry for each class of livestock, based partly on pre-war numbers of livestock on agricultural holdings and the output of milk, etc. The Ministry of Food is responsible for the supply of feeding-stuffs against ration documents, and prescribes from month to month the proportion of the main types of feeding-stuffs.

Under the controls relating to cereals and cereal products, oilseed crushing, etc., the Ministry of Food obtains returns of production of a large proportion of by-products for animal feed produced in the United Kingdom. These returns are supplemented by others from firms such as fish meal and meat meal manufacturers, suppliers of molasses for animal feed, and so on. Detailed statistics relating to the total supplies of foodstuffs made available under the animal feeding-stuffs rationing scheme are not published regularly, but summary statements have been given from time to time. A feature of the animal feeding-stuffs trade since 1939 is the large increase in the proportion of total supply of such feeding-stuffs which reaches farms in the form of balanced rations whether as compound or livestock mixtures. The pre-war output of the cattle, dog and poultry food trades represented only a small proportion of the total supply of feeding-stuffs used on farms. While a significant proportion of imported grain was before the war ground or otherwise processed before delivery to farms, large quantities of grain, oilcakes and meals and other feeding-stuffs found their way, as such, to the farms. From returns received by the Ministry of Food it appears that as much as 85 per cent. of all rationed feeding-stuffs are now delivered in the form of compounds or livestock mixtures. The figures published in the *Digest* relating to animal feeds cover barley, maize, oilcakes and meal and milling offals. Two figures are given for barley, "Brewing and Food" and "Animal Feed". The figures for brewing and food are derived from returns of production, and include barley used for brewing and barley flaking and roasting for use in the brewing industry and for vinegar. The figures for barley used as animal feed relate to barley meal and imported barley supplied by the Ministry through the animal feeding-stuffs ration pool. The consumption figures provided in the *Digest* exclude barley retained on farms for feed, but information on farm retentions of barley and other grain is available in *Agricultural Statistics, Pt. II.* In the case of maize two figures are given, "Total Disposals" and "Disposals for Animal Feed". The former includes the quantities of maize allocated to the starch, glucose and cereal breakfast food industries.

The *Digest* also gives figures for oilcakes and meals and for milling offals, whether home-produced or imported. Owing to the higher post-war rate of flour extraction the quantities of wheat milling offals produced in the United Kingdom are well below the pre-war level despite the higher rate of flour consumption, and imports of milling offals are also on a diminished scale.

c. *Sugar.*

Sufficient data are available in published records to enable accurate assessments to be made in respect of home-grown and imported sugar of stocks (raw and refined), home production, imports, exports and consumption.

* See pp. 72 and 74.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Figures of bonded stocks of raw and refined imported sugar and sugar from home-produced sugar beet were published in the bonded warehouse account of the monthly accounts of the Trade and Navigation for the United Kingdom, and in the Customs and Excise Annual Report.

Figures of total production of raw and white sugar were issued by the British Sugar Corporation. Before 1936 the United Kingdom beet sugar industry was carried on by 15 separate companies. The Sugar Industry (Re-organisation) Act, 1936, provided for the constitution of a Sugar Commission to keep the activities of the industry under review, and also provided for the amalgamation of the Companies into the British Sugar Corporation. The Sugar Commission was thus in a position to assemble statistics for the whole of the beet sugar industry, and published comprehensive annual reports giving *inter alia* the acreage contracted and the manufacturing campaign output. Tables based on these annual figures of production were printed in the publications of the International Sugar Council and in the Commonwealth Economic Committee's reviews, *Plantation Crops*.

The interpretation of these derived figures requires some care, and the various conventions observed by the different authorities publishing the figures both as to periods covered and the terms in which the quantities are expressed must be borne in mind. Thus, in the figures published in the Bulletin of the International Sugar Council the raw sugars produced have first been converted to refined at the official refining rates based on the Customs duty scale, and the total in terms of refined had been reconverted to raws at the rate of 9:10. This kind of procedure was evolved as part of the objective of the I.S.C. to achieve a common basis in the presentation of the figures. For various reasons beet sugar is often re-introduced into process, and consequently any series of weekly or monthly production figures may involve a considerable double count, which must be borne in mind in interpreting such figures. The final results of any campaign can only be stated accurately at the conclusion of the campaign (October/February). Such figures as are published on any time basis other than that of a period embracing one completed campaign can therefore at best be no more than estimates.

From the beginning of the controls weekly returns have been received from the refineries giving the amount of raw sugar melted and the production of refined sugar from imported raw sugar. The factories of the British Sugar Corporation also make weekly returns of production of raw and white sugar. The weekly figures given are not the same as the final results, because by convention any corrections for earlier figures were made in the last returns. Figures of production from home-grown sugar beet appear monthly in the *Digest* and also in the *Annual Abstract of Statistics* in the refined equivalent.

Consumption of sugar is a field in which the Ministry of Food has been able to expand considerably the information available. A complete picture is now available of the sugar used in the United Kingdom. The analysis of manufacturing usage is derived from the records of allocations made by the various authorities empowered by the Ministry to issue permits. These figures are not regularly published, but have appeared from time to time in various official publications (see, for example, *How Britain was Fed in Wartime*). Figures of total disposals and disposals for food in the United Kingdom appear monthly in the *Digest* and annually in the *Abstract*. The Ministry of Food has adopted the common refining factor for all sugars of 93 : 100. This is known to be conservative, but the advantage in practice of working with a single refining factor both for the United Kingdom and in international dealings outweighs the disadvantages.

D. *Meat.*

Livestock census returns covering holdings one acre and over were available before the war, but to obtain a disappearance figure starting with the population as shown by the census returns is virtually impossible in the absence of accurate information on births and deaths (other than slaughter). Further, there was little information availably at that time on carcase weights from which the meat output of the country as a whole could be obtained. (This difficulty was later partly overcome with the help of data derived from early wartime experience.) The published statistics of pre-war livestock production give totals for cattle, calves and sheep, but do not distinguish the various types of animals within the groups. In the case of pigs there is more information, and a division into bacon and other pigs can be made.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Livestock Industry Act, 1937, set up the Livestock Commission to review the production, marketing and slaughter of livestock, and in particular to formulate and administer a subsidy scheme for cattle. The statistics collected by the Commission covered only cattle (collected from 820 centres in the U.K. and those only in the restricted sense of "clean" cattle, i.e., steers, heifers and cow heifers). The Commission did not collect details of the number of animals slaughtered. It should be added that the number of slaughter points operating before the war is usually accepted as being about 16,000. The statistics produced by the Commission are useful in assessing the seasonality of marketing of cattle.

The present estimates of the pre-war output of meat in the United Kingdom are thus compounded of pre-war information of the animal population, and the seasonality of marketing and war-time knowledge of the relationship between census data and the recorded slaughterings. By combining this extrapolation with the data on killing-out percentages the output of meat is estimated for each class of animal.

The figures for production of carcase meat and offal in the *Monthly Digest of Statistics* and the *Annual Abstract of Statistics* for pre-war years include meat and offal from imported fat stock, fresh meat and offal from the Irish Republic and trimmings and offal from bacon pigs (as do the figures from April, 1940, onwards).

There is therefore an element of duplication with the figures for imports of meat drawn from the published trade accounts, in that both sets include fresh meat and offal from the Irish Republic (8·4 thousand tons in 1934-38 average: *Annual Statement of the Trade of the United Kingdom*).

Imported live animals.—All meat from imported live animals, whether store animals (for fattening) or fat animals (for immediate slaughter), is included in the production figures.

Since the introduction of control in January, 1940, it has been possible to obtain much more detailed and comprehensive statistical data about home production. This arises from the fact that the Ministry of Food became the sole purchaser of all fat stock and the resulting products. From the time the animal is accepted at a collecting centre to the time the meat and offal produced has been allocated to a butcher or a manufacturer it is the property of the Ministry of Food. At each point in the chain of production and distribution strict control is maintained and statistical information is available accordingly. When the animals are presented at the collecting centres the process of grading is carried out, and the returns made give information about classes and grades of the fat stock purchased for slaughter with the live weights of the individual animals (except for pigs, which are bought on a dead weight basis). In the case of pigs the numbers passing through collecting centres do not in general represent more than about 50 per cent. of the total pigs acquired by the Ministry of Food. The remainder are bought for the Ministry by the area pig allocation officers. Comparisons are made later on between the presumed carcase weight and the actual carcase as shown subsequently by returns from slaughter-houses. The slaughter-house returns are made weekly, and give the number of fat stock slaughtered each day with the actual dressed carcase weight of the meat and offal obtained. From the slaughter-house the meat is transferred to the Wholesale Meat Supply Associations, who are the official distributing agents at the wholesale level. Each Association provides a return showing in detail the quantity of carcase meat and offal distributed to the retail trade and gives details subdivided into ration meat, manufacturing meat and offal. It is at the wholesale meat supply level that home production becomes merged with supplies of imported meat. Fat stock is imported live from Eire, and the Ministry of Agriculture's Port Veterinary Officers provide weekly returns showing the daily arrivals by classes of fat stock.

E. *Bacon and Ham.*

The policy of regulating supplies of bacon for consumption in the United Kingdom under the Agricultural Marketing Act, 1933, the Bacon Industry Act, 1938 and 1939 and the Bacon (Import Regulation) Order, 1933, enables a fairly accurate picture to be drawn of bacon supplies in the United Kingdom.

The amount of bacon produced in Great Britain from home and imported pigs and carcases was recorded by the Bacon Marketing Board from returns made by curers registered under the Bacon Marketing Scheme. Similar information was prepared by the Government of Northern Ireland, who were responsible for the administration of the Bacon Marketing Scheme in Northern

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Ireland. It was therefore possible to ascertain production of bacon in the United Kingdom except for those quantities produced by small curers. It has been estimated that the output of bacon from this type of curer was 36,000 tons annually, and that a large part of this was pickled pork. Under the Scheme bacon was defined as pork which had been in pickle for more than 48 hours, and a curer producing less than 5 cwt. a week was not required to register. The figures of bacon production may be found in—

1. The Bacon Marketing Board Annual Report.
2. The Imperial Economic Committee's publications on Meat and Dairy Produce.
3. The *Annual Abstract of Statistics* or the *Monthly Digest of Statistics*.

Pre-war average commercial production was approximately 150,000 tons. In addition there was small curers' production of 36,000 tons and some 19,000 tons estimated production by self suppliers, making a total of the order of 200,000 tons. Under the Pigs Marketing Scheme the sale of bacon pigs was regulated to all curers except those curing less than 5 cwt. per week. Pig producers were required to enter into yearly contracts, and from the pig numbers thus derived the output of bacon could be forecast, thus enabling the Board of Trade to determine how much bacon should be imported into the country in order to maintain a resular supply on the home market. No such information is available of pig-killings for non-bacon purposes.

The pre-war annual average imports were 383,000 tons, of which the main suppliers were Denmark and Canada.

As soon as imported bacon arrived at the port it began its journey to the wholesalers who, after processing it, delivered it to the retail trade. Generally it was sold and consumed during the week following its arrival. Home-produced bacon was also sold as soon as processed. This means that negligible stocks of bacon were carried, and home production plus imports during any year give a fair picture of consumption for that period.

On the outbreak of war the operation of a substantial part of the Bacon Industry Acts was suspended and the Ministry of Food, through the Bacon and Ham and Meat and Livestock Divisions, took control of pig marketing and bacon production, and became the sole buyer of pigs for slaughter and sole seller and distributor of home-produced bacon. Through the control operated it is possible to assess accurately (i) the number of pigs marketed, (ii) the number of pigs used for bacon and non-bacon purposes, (iii) the weight of these pigs, (iv) weight of bacon produced from pigs sent to bacon factories.

Through the control over self-supplier pigs it has been possible to ascertain the number of pigs for which a licence has been granted to slaughter and the number which were allowed to be cured.

The actual weight of bacon going into consumption is readily obtainable from the stock records. The issues are based on permits to retailers to meet the requirements of their registered customers. It should be borne in mind that the ration is boneless and certain allowances must be made to enable the ration to be met. These arise from loss in weight while the commodity is held in the distributive chain or during processing, and include smoking, cutting, trimming and boning out for sale to consumer. These losses amount in total to about 20 per cent. of the original weight of bacon.

F. *Milk and Milk Products*

Statistics are fairly comprehensive for the pre-war period. This is the result of a policy of encouraging production and consumption of home-produced milk and milk products under the Milk Marketing Schemes which were set up under the Milk Acts 1934-37 and 1938, and the restriction of imports first by agreement and later by the "Processsed Milk (Import Regulations) Order, 1939".

Milk was sold at prices varying according to the product manufactured; the pre-war average for manufactured milk was 6*d*. per gallon, whereas that sold for liquid consumption was about 1*s*. 4*d*. It was necessary therefore for manufacturers to submit to the Board monthly statements showing the quantity of milk used for each product and the weight of the product produced. From such information the Milk Boards were able to give accurate statements of the weights of the various products. This information is published in various official documents and by the Imperial Economic Committee (now the Commonwealth Economic Committee). No accurate

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

record was available for the production of farmhouse butter and cream. The production of farmhouse cheese came within the scheme, and the producers were subsidized and had to submit statements of the weight of cheese produced and sold. The output of butter and cream on farms was obtained for the year 1935-36 under the Agricultural Census, and estimates have been made since then taking into account the changes in farming practice, including the increased volume of liquid milk sold off the farm which had previously been used for butter-making and stock-rearing. Under the Milk Schemes manufacturers were not obliged to give details of the skimmed milk products produced, but in 1934 the Market Supply Committee began to collect data on the output of milk products, including skimmed products. In the areas of Scotland where milk marketing schemes did not operate, production in creameries did not take place because the price differential between the liquid milk price and that of milk products made it uneconomic.

Imports were controlled by agreement with exporters and later by the Processed Milk (Import Regulations) Order, 1939. Data on imports are available from the Accounts of Trade, *Weekly Dairy Produce Notes* and the Imperial Economic Committee's publication on Dairy Produce.

Generally a year's imports plus home production of cheese, condensed milk and milk powder would give a reasonable picture of consumption during that year, as stocks held by traders would not normally vary sufficiently to affect the consumption figures to any great extent. With butter, however, it became customary to keep excess supplies in cold store during the first half of the year for use during the second half. This practice did cause stocks of butter to vary considerably from year to year.

Unlike other Marketing Boards, which ceased to operate at the commencement of war and were incorporated in the Ministry of Food, the Milk Marketing Board retained its separate identity. This has meant a continuation of the pre-war machinery for the collection of statistics, enlarged and enriched by the information derived from controls.

Manufacturers of milk products are licensed by the Ministry of Food, and liquid milk is allocated to them from the Milk Pool under the Milk Utilization Programme. Apart from this some makers of cheese use milk from their own cows. This cheese is termed "farmhouse" to distinguish it from other cheese, termed "creamery". Production figures are obtained from the grading and production certificates which the manifacturers send to the Ministry, and upon which the purchase of a product is made. Some butter is also made by the self-suppliers for home use and not for resale, but this amount is small in comparison with the total supplies, and is calculated from estimates prepared by the Ministry of Agriculture of milk retained on farms for this purpose. The Ministry's stock records of cheese and milk powder do not include those imported privately, but figures of consumption of these commodities published by the Ministry of Food take these items into consideration. Consumption figures published for milk powder relate only to full-cream and skim powder.

G. *Potatoes*

Estimates of the acreage under potatoes in the United Kingdom have been made by the Agricultural Departments for each year since 1866. Estimates of potato production are available from the same source as far back as 1885. From 1934 until the outbreak of war the Potato Marketing Board's annual report gave data on the distribution of potato acreage in Great Britain among the main varieties of potato, on the relative frequencies of growers holding varying potato acreages, and on the distribution of the total potato acreage among growers in the several potato acreage categories. An annual pamphlet of the Board entitled *The Area under Potatoes in Great Britain* gave an analysis by variety of the acreage held by registered growers in each county.

Potato imports were separately distinguished in the Import List certainly as early as 1820. Before 1934 the Annual Statement of Trade showed all imports under the simple heading "Vegetables, Raw—Potatoes". In 1934 the distinction between new and other potatoes was introduced into the accounts, and in 1948 seed potatoes were for the first time separately distinguished.

Estimates of consumption for the immediate pre-war years has been based primarily upon the estimates of production made by the Agricultural Departments. In these estimates the utilization of commercially-produced potatoes for human consumption in the United Kingdom was computed as the balance remaining from total production after allowing for seed usage, chat potatoes (those too small to stand on the minimum ware or seed riddle), ware fed to stock on farms, wastage and

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

exports. For this purpose seed usage was calculated from estimated seed rates per acre, while the allocation to chats was based on crop reporters' estimates. The allowance for wastage and ware potatoes fed to stock on farms was no more than a reasonable guess informed by the experience of later years, when it was possible to calculate this item as the difference between two quantities estimated independently of each other and from objective data, viz., production and total other utilization.

This is the basis of the pre-war figures given in Tables 184 and 192 of the *Annual Abstract of Statistics*, No. 86. The figures are estimates of quantities moved through the farm gate and into United Kingdom ports for the purposes specified in the tables, and they include an allowance for potatoes used as food on the farm.

The principal innovation since 1939 is the collection of statistics of the movement of ware potatoes off the farms. A subsidy upon first-hand transactions in potatoes was introduced in mid-1941, and it became possible to compile movement statistics from the claims for subsidy submitted by those who were licensed by the Ministry of Food. In September, 1939, the organization of the Potato Marketing Board was absorbed by the Ministry of Food, and the censuses of acreage farm stocks which the Board had inaugurated were maintained and made more comprehensive. The war and post-war returns have in fact covered all growers eligible for the potato acreage payment, that is, those holding one acre or more of agricultural land and not less than one-tenth of an acre of potatoes (one quarter of an acre of potatoes has been the minimum qualification in Northern Ireland during the period; it became the minimum qualification in Great Britain in 1950). During each of the seasons from 1943-49 merchants licensed for first-hand transactions in seed potatoes were asked to make returns of their monthly first-hand dealings in seed (that is, sales of seed of their own production and purchase from growers not licensed as seed merchants). The transport arrangements made for the despatch of Scotch seed to England and Wales have provided an accurate record of this movement for the seasons since 1942-43. The movement of seed from Northern Ireland to England and Wales has been well documented in the records of the Northern Ireland Ministry of Agriculture and in the Potato Division of the Ministry of Food. In the autumn of 1947 a scheme was instituted for estimating main-crop yields by digging and weighing the produce of sample plots immediately before harvest on farms throughout Great Britain. The results are obtained each year from 1,900 to 2,200 fields. In each case the yield over several alternative riddles is ascertained as well as the yield of all potatoes, including chats and waste. The data are collected so as to be classifiable by variety of potato, type of soil, size-category of grower (judged by total potato acreage) and county.

H. *Fresh, Frozen and Cured Fish*

Three Departments—the Ministry of Agriculture and Fisheries, the Scottish Home Department* and the Ministry of Commerce (Northern Ireland)—have authority over the catching of fish by British vessels. Before the war† all three published comprehensive reports dealing with the various aspects of their responsibilities. These are the source of pre-war information on supplies landed by British vessels. The trade accounts record the imported supplies of fresh, frozen and processed fish. In the case of fresh fish imported supplies include those landed direct from the fishing grounds by foreign vessels as well as those carried as cargo. From the same source the considerable pre-war export trade, which was largely in pickle-cured herrings, and the small entrepôt trade is ascertainable. The reports of the three departments and the trade and navigation accounts together provide an overall picture of supplies in the form in which they were landed.

Fish is preserved by drying, smoking, curing or marinating and may be canned or manufactured into fish cakes and fish paste. The report of the 1935 Census of Production covered the "curing, smoking and salting of fish" by the large firms engaged in these activities. The output of small firms was considerable, however, and represented 15·8 per cent. of the value of the total gross output recorded in the comprehensive census of 1924. Output was analysed in the 1935 report according to the variety of fish used, but the type of cure employed was not distinguished.

* Prior to the Reorganisation of Offices (Scotland) Act, 1939, responsibility lay with the Fishery Board for Scotland.

† Publication of these was discontinued during the war.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The gross output in 1924 of the so-called small firms was considerable for most varieties of fish, and was particularly important in the case of herrings, in which the curing trade is highly seasonal. The exclusion of a significant part of the trade in herrings arose because small firms were defined as those "employing not more than ten persons *as a yearly average*"; thus some firms which, during the season, employed more than ten persons were excluded. The report also dealt with the quantities in the fresh state of the fish cured, smoked and salted. Satisfactory deductions cannot be made about the loss of weight due to processing, however, because these vary according to the type of cure. The report also referred to the canning of fish, but did not distinguish fish from meat and poultry pastes, nor did it refer to the production of fish cakes. The output of processed fish given in the report of the 1935 census because of the restricted coverage is not comparable with the exports of processed fish shown in the Trade and Navigation accounts. From the reports of the Herring Industry Board which referred to the disposal of the herring catch and the mode of treatment, the latter are known to have been mainly of pickle-cured herrings.

For the reasons given above, estimates of pre-war consumption can best be made in terms of the condition of the fish as landed rather than the form in which it was consumed. Account of the wastage in preparation (i.e., filleting) which took place in the course of distribution or in the home can be taken on the legitimate assumption that fish landed by British vessels was landed whole,* but that of certain varieties of imported white fish were headed before landing.

The Departments concerned with fisheries continued to exercise authority over the catching of fish by British vessels during the war, and the Ministry of Food's authority over British caught fish began when it had been landed at the quay side. Over the procurement of imported fish the Ministry's responsibility was wider. In the case of Iceland, for example, contracts were made for the purchase of the exportable surplus of white fish from July, 1941, to December, 1944.

A scheme for controlling the distribution of all fish came into operation on the outbreak of war. For various reasons it was revoked within the month, and it was not until October, 1942, when the need for the utmost economy in transport was acute and when the growing shortage of other foods demanded a more equitable distribution of the limited supplies of fish, that the Ministry again controlled the distribution of supplies, but on this occasion control was restricted to white fish only. In the intervening period, however, a number of controls were introduced, some of which provided statistical data. These included general price control and the allocation of supplies at ports.

Primary allocation at the ports became essential when the normal system of auctions disappeared under maximum price control. Price control was imposed on herrings in October, 1939, and supplies later became subject to allocation at first hand. In the case of white fish similar controls were not introduced until June, 1941. The records of the Ministry's allocations officers, who were responsible for the day-to-day supervision of allocation, provided details of supplies of fresh fish and edible offal landed at the ports, of prices realized, of supplies condemned as unfit for human consumption and those of edible fish taken by fishmeal works in times of glut. In the case of foreign-caught fish, the type and nationality of the vessel bringing supplies and the country of origin or, in the case of landings direct from the fishing grounds, the waters in which the fish were caught were also known from other records. It has already been pointed out that before the war fish landed by British vessels was in the whole state, but that some foreign-caught fish was landed headless and gutted. The critical shortage of fishing vessels during the war made the utmost use of all available stowage space a matter of first importance, and catchers were encouraged to head and gut as much fish as possible at sea by a financial incentive incorporated in the first-hand maximum price structure. The special prices which provided an inducement to land headless fish were continued until 1946. From then until the time of decontrol in the spring of 1950 there were several changes in policy regarding headless fish, but it was not until the return to a free market that landings of headless fish virtually ceased. During allocation control the condition of the fish when landed was therefore also recorded and the edible content of supplies could consequently be assessed.†

* Some varieties landed by both British and foreign vessels were normally gutted at sea but were otherwise whole.

† The Ministry of Agriculture and Fisheries published statistics relate to the fish as landed, whereas those of the Scottish Home Department are in terms of the equivalent whole fish. Landings in N. Ireland are mainly of whiting, which are landed whole.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Processors of both white fish and of herrings who disposed of their products by wholesale were required to hold a licence authorizing such processing. Information was needed about their output, and, generally, their stocks of finished products in addition to their use of fresh fish and, where appropriate, of processed fish. In the case of white fish the products included smoked fish, wet and dry salt fish, fish cakes and fish paste. In 1946 the quick freezing of fish was of sufficient importance to justify the collection of information on this product. Technical improvements in the freezing of fish towards the end of the war led later to the installation of the necessary quick-freezing plant. Considerable importance was attached to this process as a means of improving the marketing of supplies and as a contribution to the solution of the problem of seasonal variation in supplies, and some assistance was given to firms who wished to develop the process. From 1946 these firms therefore provided information on their output of quick-frozen white fish and herrings and on their use of fresh fish.

Supplies of herrings taken by processors were known as a result of the allocation scheme because wholesalers of fresh herrings ("freshers"), kipperers and canners shared the available supplies until 1944. By that year supplies had improved and, with the prospect of a market for pickle-cured herrings in liberated Europe, a modified scheme was introduced which made provision for any balance of supplies after the requirement of "freshers", kipperers and canners had been met to go to pickle curers and redders. The Ministry purchased the pickle-cured and red herrings, which were mainly exported to Europe, but curers could buy back supplies needed for the home market. These controls, in addition to providing statistics of supplies taken at the ports for the various types of processing, also resulted in a knowledge of the production, sales and stocks of pickle-cured and red herrings. Processors of kippers, bloaters, etc., also reported on their output and stocks and on their use of fresh fish.

The reports of the Herring Industry Board, whose operative powers had been largely suspended during the war, for 1946 and subsequent years refer to the utilization of the home catch for the fresh market and for processing, including two post-war developments in processing with which the Ministry was concerned. One of these, the quick-freezing of herring, has already been mentioned. The other was concerned with finding an outlet for supplies surplus to the requirements of the home and export markets. This scheme, which involved the reduction of herrings into oil and meal, was introduced in 1946 and was subsidized by the Government. It was administered by the Ministry until 1948, when it became the responsibility of the Herring Industry Board, who report on this new outlet for supplies.

The controls introduced in 1942 made it possible to assess the available supplies and also consumption of both fresh and processed fish. For purposes of comparison with the pre-war period, however, the published estimates of consumption relate to supplies in the form in which they are landed. From 1945 to 1950 there was a gradual relaxation of controls, and in the spring of 1950 when the danger of shortages and steep rises in prices no longer appeared likely the remaining licensing and distribution controls were removed and price control was abandoned. The statistics deemed essential for the maintenance of supply and consumption estimates have been maintained, however, and adapted to meet the changed conditions. With the end of price control it also became necessary to institute a collection of retail price quotations in order to assess consumer expenditure on fish.

1. *Oils and Fats*

Imported supplies account for practically all the U.K. requirements, and the imports recorded in the Trade and Navigation accounts give a sufficient indication of the pre-war utilization of oilseeds, vegetable oils and marine oils. There were of course stock changes, but these were only available after 1936, when the Food (Defence Plans) Department of the Board of Trade began to collect them. Over a period of years, e.g., 1934 to 1938, utilization can be equated to average imports without serious error. Only for lard, dripping, tallow and similar animal fats was home production at all significant. Estimates of lard production were made annually by the Bacon Development Board. Production of tallow and other animal fats was not known at the time, but estimates were made subsequently by the War Time Fat Melters' Association.

Production of margarine and cooking fat was estimated by the Imperial Economic Committee on the basis of returns by manufacturers covering about 85 to 90 per cent. of the national

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

production. The quantity of various oils and fats used annually in soap production was similarly estimated by the I.E.C.

Following the outbreak of war information was supplied by various war-time associations relating to production or consumption in the "datum period" February/July, 1939; this information was required for administering restricted supplies, but incidentally threw much light on details of pre-war consumption.

Strict control operated from the outbreak of war, a control made easier because virtually all our supplies are imported.

Stocks of all raw materials were Ministry owned and controlled to the point at which they were sold to an end-user such as soap in linoleum manufacturing—except for oils used in the manufacture of margarine and cooking fat. Here the Ministry controls the factories and retains ownership of the materials at all stages of processing until the finished article is sold to the official distributing agency, Marcom Limited.

Control is largely decentralized and operated by trade associations acting as the Ministry's agents. Thus the National Association of Oils and Oilseed Brokers arranges the unloading of shipments of oils and oilseeds, allocates them to factories and storage in the port areas, arranges the detailed fulfilment of the oilseed crushing programme, moves oils to the margarine plants, etc., and finally supplies the Ministry with statistics of its complex operations.

3. *Other Processed and Manufactured Foods*

Between 1907 and 1935 the Board of Trade took five censuses of production, the last pre-war census being in respect of 1935 and the first post-war in respect of 1948. The reports on these censuses are the main source of information on pre-war output, and on the usage of raw materials for the processed and manufactured food industries.

The census relates to industrial production and does not cover agriculture. Factory production of dairy products, for example, falls within its scope, but not the production on farm dairies, which are considered appropriate to agriculture.

The census is nominally in respect of the calendar year of its title, but respondents are allowed to record particulars of their trade during the business year of their respective firms. The actual periods covered by censuses have varied in relation to the calendar year because of changes in the instructions about this concession. In 1935 respondents had to record particulars for the business year ending between April 7th, 1935, and April 8th, 1936, and the concession for subsequent censuses has been similar. The information recorded in the 1935 census stretched therefore over the two years April 9th, 1934, to April 7th, 1936. While it seems unlikely that firms engaged in the same seasonal trade will have markedly different business years, this is not impossible. Should it occur, output relating to the harvests of differing crop years may be recorded in the same census. The "floating year" is of less significance in the less seasonal and non-seasonal trades.

The first census in respect of 1907 and the third in respect of 1924 covered all establishments irrespective of size, but the smaller establishments were exempted from the intermediate censuses and also from that for 1935, when firms employing on an average not more than 10 persons were exempted. An experiment was made in 1935 with a simplified schedule for small firms in the baking trade, and this technique was extended to a few other trades in the 1948 census. Other trades in which firms employing ten or fewer persons produce a proportion of the total output which is more than negligible are not fully covered but, in the case of the 1935 census, the results of the 1924 census with its comprehensive coverage are a guide to the scope of the 1935 census.

The section on output in schedules for pre-war censuses sought the quantities and net selling values of goods "*made* in the year of return or sale, whether sold in that year or not". The corresponding section of the 1948 schedules sought information on goods "*sold* in the year, whether produced in the year or not". In order to deduce physical production it is necessary to know changes in stocks of the finished product in addition to actual sales, and the 1948 schedules included a section for stocks at the beginning and end of the year of return.

Because the 1948 census recorded, as already pointed out, "goods sold", any assessment of total output may be understated for those products which are used by producing firms for further processing. These firms will not "sell" the intermediate product to themselves unless they regard their producing units as separate establishments for accounting purposes. Where this accounting convention is followed, the schedules for 1935 and 1948 instructed respondents to complete a

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

separate schedule for each establishment. In these cases, therefore, a complete record of output of the intermediate product would be obtained, but in other cases where, for accounting reasons, firms did not distinguish between their departments, the production of an intermediate product would be incomplete. This cause of understatement of output in the 1948 census is, however, removed in some cases, where a considerable quantity of an important intermediate product is further processed by the firm making it, by asking firms to record the total quantity *made* in the year of return as well as the quantity *sold as such*.

For census purposes firms (or production units of firms where such a distinction is made for accounting purposes) are classified according to their major activity. A firm engaged mainly in, say, biscuit-making is asked for a detailed analysis of its output of biscuits under eleven headings in 1948. On the other hand, a firm mainly engaged in baking bread or cakes but which also makes biscuits is regarded as in the bread and flour confectionery trade. Such a firm's output of bread and cakes has to be analysed in the schedule under sixteen different headings in 1948, but its biscuits have only to be classified under two headings. This difference in the amount of detail sought about a product according to whether its production is the main or only the subsidiary activity of a firm is based on the reasonable presumption that a firm primarily engaged in, say, biscuit-making will produce more varieties than one whose main activity is in another product. Where a significant proportion of the total output of any product is made by firms primarily engaged on another product, the census provides less comprehensive information on the detailed composition of the output of that product than of other products.

The trade accounts are the main source of pre-war information on imported supplies of foods discussed in this section and on the export and entrepôt trade. Comparisons between these statistics and those which arise from the census of production may be invalidated by some of the characteristics of the census discussed above.

The necessity for conserving man-power and also supplies of ingredients and ancillary materials during the war involved the control of production and the licensing of producers, the allocation of raw materials for many processed and manufactured foods and some quality controls on products. The policy of equitable distribution resulted in the control of the distribution of these foods through rationing and other schemes. The operation of these and other controls made it necessary to collect from the trade considerable information on current production, sales through the various channels of distribution and stocks of the finished product and on the use of raw materials. Schemes such as those for the concentration of industry and the zoning of deliveries necessitated surveys of industrial capacity, output, sales, etc. When the Ministry was the purchaser of imported or home-produced supplies accounting records provided details of purchases, releases and stocks. The following sections deal with the relevant controls exercised over the principal processed and manufactured foods not already discussed and the statistics to which they gave rise. Controls on less important foods listed in Appendix I also necessitated the collection of statistics.

Preserved fruit and vegetables.—The 1935 census of production in a schedule on the preserved foods trade covered firms mainly engaged in the production of "preserved meats and fish (except bacon and ham and cured fish), preserved fruit and vegetables, pickles, sauces and condiments and kindred goods". In the section on output the report distinguished the preservation of vegetables by drying, canning or bottling and brining, and the preservation of fruit by canning or bottling, by manufacture into jam or marmalade and by other modes such as crystallization. No reference was made to the output of fruit pulp, which is made mainly by manufacturers for further processing into jam and marmalade because output was restricted to that of "goods made for sale". The exclusion of the output of small firms was probably of little account; their output for the preserved foods trade as a whole was only 1·7 per cent. of the total in 1924.

Information on the considerable import trade in canned or bottled fruit and vegetables and in fruit pulp is available in some detail in the trade accounts. These accounts also cover the foreign trade in other types of preserved fruit and vegetables such as jam and marmalade, brined vegetables, pickles and sauces and fruit pectin.

In the seasons 1942 to 1947 inclusive the Ministry controlled the bulk of the soft fruit crops by pre-emption in the main growing areas. Highly flavoured fruit supplies were diverted mainly for manufacture direct into jam (or into fruit pulp for subsequent jam manufacture) to ensure the maintenance of supplies for the ration. Black currants for the manufacture of *purée* and syrup

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

were pre-empted for manufacturers in the same way as for preservers. The pre-emption scheme necessitated returns from processors of their receipts, wastage and usage of these fruits. The returns were later extended to cover home-grown orchard fruits and imported fruits, notably citrus fruits, and also additional types of preservation such as canning, quick-freezing, etc.

Processors of fruit and vegetables were generally licensed, and called upon to provide information about finished products and of the use of allocated ingredients. Jam and marmalade manufacturers, for example, were licensed from 1941, when preserves rationing was introduced and standards were laid down for the fruit and sugar content of the product, to 1950. Sugar was allocated first in relation to pre-war use, later in relation to targets set for the production of jam and marmalade, and, still later, on recent sales, which is the current basis. The Ministry was the sole importer of fruit pulp, and distribution was made through the Fruit Pulp Association. Pulp, other than citrus pulp, was also allocated in the first place in relation to pre-war usage, later in relation to target production, and still later, in relation to sugar allocations. In 1950 it was freed from control. Citrus pulp, however, was freely offered. The Ministry also purchased home-produced plum pulp and sold it to jam manufacturers, and imported bitter oranges, which were allocated like fruit pulp until 1946, after which they were supplied on request. Pectin which was home produced and also imported by the Ministry was allocated in the same way as fruit pulp. Jam manufacturers who made fruit pulp and manufacturers of fruit pulp who were not also jam manufacturers were called upon for returns of their production, sales or usage and stocks of this intermediate product.

Licensing control over the commercial canning of fruit and vegetables was introduced in 1942 and is still operative. It was exercised by first issuing a licence permitting the canning of fruit or vegetables, and then controlling the actual canning of every particular variety by direction. When the overall production programme was below industrial capacity a firm's production quota was based on pre-war production in a datum period, and the allocation of raw materials such as sugar and ancillary materials including tinplate was then similarly based. The only control on bottling was the grant of a licence for those producing 20 cwt. or more, and this was not required after September, 1947.

The quick freezing of fruit and vegetables was in its infancy at the outbreak of war and was suspended for the duration of the war. Subsequently production was permitted under licence, and this restriction was lifted in 1950.

Vegetables preserved in vinegar are a part of the pickles and sauces industry which it is convenient to refer to here, although other products such as sauces, salad creams and dressings, chutney, sandwich spread, etc., are also made. The licensing of concerns which produced more than 3 tons a year was introduced in 1942. Monthly returns of production (distinguishing varieties of products), sales and stocks were required from establishments making more than 50 tons a year. There were at the outset about 145 such concerns, and their combined output was estimated to be about 95 per cent. of the total for the industry. Ingredients, with the exception of some fruit and vegetables, were allocated by the Ministry on an annual production target basis. Production and distribution were freed from control in July, 1949, but voluntary returns are still made in regard to finished products and the use of sugar.

Chocolate and sugar confectionery.—The report on the 1935 Census of Production gives an analysis of the output of the principal types of cocoa preparations and sugar confectionery made by large firms only. In 1924 the value of the gross output of small firms represented 2·7 per cent. of the total, the principal class of foods affected being sugar confectionery (5·3 per cent.). The volume of the trade in sugar confectionery in 1935 was rather higher than that in cocoa preparations, but the value of the trade was considerably less. Another feature of the trade was the significant proportion (7·0 per cent.) of the output of sugar confectionery made by firms whose main activity was in another trade.

The trade accounts provide considerable detail on both imports and exports but, owing to the difficulty of definition, do not distinguish clearly between cocoa preparations for further manufacture and chocolate confectionery, which is a finished product.

Through the co-operation of the Cocoa and hocolate (War-Time) Association and the Sugar Confectionery (War-Time) Association,* the Ministry exercised control over the major sectors

* Later incorporated in one body known as the Cocoa, Chocolate and Confectionery Alliance, Ltd.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of this industry. These included the production of chocolate, chocolate confectionery and couverture, sugar confectionery, cocoa powder, drinking chocolate and cocoa butter. Membership of the War-Time Associations was not made compulsory but, at the height of control, 2,000 out of about 2,500 manufacturers were members of one or other of the Associations. When the Ministry required the licensing of all manufacturers who in the year 1940 or any subsequent year produced more than 25 tons of the controlled commodities, only 600 to 700 licences were issued. Thus a high proportion of the 2,500 manufacturers were in the small-to-medium class.

The rationing of confectionery, with the exception of the short period April to August, 1949, has been in force since 1942. It necessitated the completion of returns by manufacturers about their products. Raw materials were allocated against buying permits in proportion to pre-war usage subject to varying war-time scarcities, and returns were called for as a check against the misuse of ingredients or the accumulation of excessive stocks. Since 1946, when imports of sugar confectionery were resumed on a limited scale, importers have also been required to submit returns showing their stock position and sales.

To ensure the availability of adequate quantities of the cheaper varieties, a price-category control was introduced in 1941. The general effect of this was to freeze each manufacturer's distribution of his output between qualities as it was in the September quarter of 1940. In order to check the working of this scheme, which was administered by the Trade Associations on behalf of the Ministry, the 250 largest manufacturers (who made approximately 95 per cent. of the total output) sent returns of their production by categories to the Associations. This scheme was brought to an end in 1949, when it was no longer deemed necessary.

Biscuits.—In the 1924 Census of Production the biscuit trade was not separately surveyed but was included with the bread trade. In 1935, however, it was treated separately, but the adequacy of the coverage due to the exclusion of small firms in the later year cannot be readily assessed. When the progress of the war made closer supervision of the use of materials, manpower and factory space essential the Ministry decided to license all manufacturers of more than 12 tons per annum and to allocate raw materials to them. The basis of allocation was the pre-war usage ascertained by questionnaire. The results of this questionnaire therefore provided an estimate of pre-war (July, 1938, to June, 1939) output, which is considerably more comprehensive than that of the 1935 census.

The trade accounts distinguish the foreign trade in sweetened and unsweetened biscuits.

From the outbreak of war till 1941 only a loose control over the biscuit industry was necessary. In 1941 the licensing of manufacturers, to which reference has already been made, was undertaken. Allocations of raw materials (sugar, oils and fats and dried fruit) at first on the basis of pre-war use and later in relation to a target production were made by the issue of buying permits to the larger firms and to those producing twelve tons or less per annum.

Points rationing of biscuits began in June, 1942. It was necessary for the working of this scheme for all manufacturers, irrespective of the size of their output, to be licensed, and to make returns for each ration period of their production, sales and stocks of the various varieties of biscuits. The total use of wheaten flour had also to be stated. This latter information was used as part of an overall estimate of the use of flour and served as a check on the working of the Flour Economy Scheme of 1946–47, when biscuit manufacturers were restricted to 72½ per cent. of their flour consumption in the first quarter of 1946. Returns from importers and exporters were also collected. The legitimate disposal of imported biscuits within the framework of rationing and of price control had to be insured, while the quantities exported were needed in connection with the replacement of materials under the Export Incentives Scheme introduced in 1947. This scheme provided for the supply of additional sugar for manufacture for the home market commensurate with the exporters' success in selling to "desirable" markets, and for the sale of certain ingredients to exporters to such markets at prices which excluded the Ministry's usual administrative charges.

Soft drinks, cider and perry.—The report on the 1935 census deals in one section with large firms wholly or mainly engaged in the production of "table waters, cider, British wines, vinegar, etc." From the 1924 census we know that the value of the gross output of small firms in that year was 17·3 per cent. of the total of all activities in the group, and that for table waters the proportion was 22·2 per cent., while for other soft drinks it was 18 per cent. and for cider and perry 18·6 per cent. The output of soft drinks as shown in the 1935 census was therefore probably

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

considerably underestimated. Output is likely to have increased markedly between 1924—the last pre-war census covering both large and small firms—and 1935, as the average number of persons employed rose from 19,300 to 24,000. The results of the 1935 census show that the value of the gross output of soft drinks, cider and perry was about 80 per cent. of the total for the group. It also showed that about one-quarter of the output of fruit juice drinks, syrups and cordials was made by firms whose main activity was in another industry.

Early in the war, manufacturers of liquid soft drinks in common with manufacturers in other sugar-using industries were allocated sugar on the basis of their use in the year ended July, 1939. The percentage of datum use adopted for an industry was related to an assessment of its utility. In 1941 a survey was taken of the sales of these drinks in the year ended June, 1941, by all recipients of allocations of sugar for these drinks. Later in the year a second survey was made of the output, capacity and man-power of all firms making more than 25,000 gallons a year for the purpose of discovering whether, and to what extent, concentration of production could be applied to the industry. Following these surveys targets for the production of concentrated and unconcentrated drinks were fixed so as to yield the same amount of drinkable liquid as was produced in 1940–41, but doubling the output of concentrated at the expense of unconcentrated drinks.

In 1942 the Soft Drinks Industry (War-Time) Association was formed to represent the trade and co-operate with the Ministry in achieving equitable concentration of the industry. The scheme thus devised was put into effect in February, 1943. It involved not only concentration of the industry, but other controls, such as the standardization of most types of drinks.

With the introduction of target production and standardization of drinks allocations of sugar were related to these targets. The various controls necessitated calling on the trade to complete returns of their sales of drinks and of their receipts, use and stocks of allocated raw materials. The returns were made to the Association by licensed member manufacturers. Non-members, including manufacturers in Northern Ireland, sent returns direct to the Ministry, but in this case production, instead of sales, was recorded. When in September, 1942, a manufacturing licence was first required for the production of packing of liquid soft drinks caterers and small producers were exempt, but later licensing was extended to cover these also.

Many of the war-time controls over the industry were lifted in stages starting in the autumn of 1947. Manufacturers have still to be licensed, however, and must conform to certain quality standards. They continue to receive sugar through allocation control. When the Association ceased to operate in January, 1948, arrangements were made for manufacturers to send their returns direct to the Ministry, but information was subsequently sought in respect of production instead of sales.

Cider makers can be divided into two clear classes—commercial and non-commercial. The former account for about 90 to 95 per cent. of the total output, most of which is made by the forty-odd members of the National Association of Cider Makers, but there are a large number of non-commercial makers who are mostly farmers and innkeepers.

The cider industry was not subject to licensing or any form of statutory control. Owing to the nature of the product considerable variation is possible both in the method of its production and in its final character. Effective control could hardly have been enforced therefore except in respect of the allocation of sugar and of saccharine, which was the only point at which any control was exercised. This modicum of control continues in the case of sugar.

Commercial producers have provided information about their production, sales and stocks of cider and their use of sugar and saccharine, and also about the fruit pressed and juice produced.

Perry is not only a drink in its own right but may be blended with cider and is made by cider manufacturers. Some information on the sales of perry, the use of perry pears and the juice produced has been sought from the trade in conjunction with that obtained for cider.

III. *Food Consumption and Production*

The measurement of food consumption per head.—Estimates of the country's per head food consumption were made in a joint study with the United States and Canada in 1943. The methods employed and the results of that study are described fully in *Food Consumption Levels in the United States, Canada and the United Kingdom.* Further results have been published in respect of the three countries (U.S. Department of Agriculture, Washington, 1944 and 1946) and in respect of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the United Kingdom only (CMD. 7203 and 7842, and Ministry of Food Bulletin, August 11th, 1951).

The basic formula of these studies is that total supply = home production + imports ± change in stocks. From this total supply deductions are made for non-food uses (industrial uses, animal feed), exports, waste and duplications. A commodity may be measured either in its primary form or at some later stage of processing (e.g., butter and cheese may be measured as products or in terms of liquid milk. If measured as products, the quantity of liquid milk used in their manufacture must be excluded under "duplications"). Most composite foods (e.g., cake and flour confectionery) are dealt with in terms of their ingredients.

The necessity to express in one figure the consumption of certain groups of commodities led to the use of common denominators. For example, the consumption of meat of all kinds was expressed in terms of carcase weight equivalent and edible weight. This made it possible to add together boneless meat, bone-in meat and bacon. Similar methods were applied to milk and milk products (milk solids), fruit and fruit products (fresh fruit equivalent), butter, margarine, lard, etc. (fat content), eggs and egg products (shell-egg equivalent), fish, poultry, game (edible weight), sugar, honey glucose (sugar content). In making international comparisons of group totals there is no difficulty about the use of such denominators with the possible exception of "carcase weight equivalent" of meat. In this case canned corned meat is converted to carcase weight equivalent by multiplying by $2\frac{1}{2}$, because a ton of canned corned meat is made from $2\frac{1}{2}$ tons of carcase meat. In the case of the United Kingdom, which imports all its canned corned meat, the device is questionable, since the by-products of canning are not consumed in this country. It is for this reason that the alternative measure of "edible weight" is now used exclusively in U.K. publications.

The expression of these results in terms of calories and nutrients makes it possible to give a value to the aggregate diet, and to compare the consumption at different times and in different countries.

The results for certain periods are given below:

United Kingdom Food Consumption

per head per day

	Pre-war	*1944*	*1947*	*1948*	*1949*	*1950*
Animal protein . . .	42·7	41·4	43·0	41·1	42·2	46·0
Total protein	79·9	87·1	90·7	87·5	88·0	88·8
Fats from all sources . .	130·2	124·0	105·4	107·6	118·8	130·6
Calories	3,000	3,010	2,880	2,890	3,000	2,990

It is hardly necessary to point out that useful as these averages are as indication of the trend of food consumption as a whole, they need to be supplemented by estimates of the consumption by the various socio-economic groups contained within the averages. As they stand one can only draw the inference implied in the movement of the separate averages in the light of the virtual certainty that the effect of rationing, redistribution of income and full employment have reduced the dispersion around the mean since pre-war days.

International comparisons have since the war been undertaken by the Food and Agriculture Organization of the United Nations (see Food Balance-sheets, April, 1949) and the Organization for European Economic Co-operation (see *Food Consumption Levels in O.E.E.C. Countries*, Paris, 1951).

As a result of differences in the method of measuring carbohydrates the British calorie level as measured by F.A.O. factors is higher than when computed on Medical Research Council factors. This point should be borne in mind in making comparisons among countries (see appendix to CMD. 7842). The F.A.O. and O.E.E.C. publications referred to use factors based on *Food Consumption Tables for International Use* (F.A.O., October, 1949).

In order to obtain such estimates and further information on consumer habits generally, the Ministry has carried out regular consumer surveys since 1941, the most important of which, the National Food Survey, investigates the levels of food expenditure, consumption and nutrition of representative samples of households by means of detailed records of weekly purchases and consumption. There is naturally no exact correspondence between estimates of consumption

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

derived from this source and the national estimates calculated from total supplies entering into distribution for civilian consumption. The former represent the quantities of food consumed in the home and omit all meals eaten outside in catering establishments and elsewhere, as well as such items as sweets, ice-cream, soft and alcoholic beverages, whose consumption is of a more personal character and more difficult to measure with any precision. Moreover, up to the end of 1949 the Food Survey was limited almost entirely to working-class households. During the war and the immediate post-war years it was not practicable for the Ministry to undertake a detailed and systematic study of this material beyond what was necessary for guidance on matters of policy and administration. More recently, however, it has been possible to put in hand a complete re-examination of all available data, and a first report, covering the period up to 1949, has been published. This will be followed by others dealing with special aspects of the inquiries and bringing the information up to date. Some of the findings of the Ministry's Food Survey have already been published by the British Medical Association in its *Report of the Committee on Nutrition*, 1950.

At various times other consumer surveys have been carried out for special departmental purposes. A Points Rationing Survey provided information on the demand for points foods in different parts of the country, and was of considerable assistance in maintaining an equitable distribution of these foods and in adjusting their points values. When bread was rationed, a similar type of survey enabled a close check to be kept on purchases of bread and flour confectionery. In the past two years, with the prospect of derationing or relaxing the controls on certain commodities, a number of surveys have been conducted on the take-up of rationed foods and on the effect on consumer demand of changes in prices and supplies. Most of the information obtained is necessarily of a confidential nature, but some results on ration offtake and milk consumption have been published in the Ministry of Food Bulletin. Finally, in this context, mention may be made of the Body-weight Survey which was carried out at regular intervals from 1943 to 1950 on a large sample of the population drawn from all age-groups from fourteen years upwards. This inquiry was designed to reveal any significant changes in body-weight and, together with other information of a nutritional and medical character, to give warning of any serious deterioration in the national diet. A full description of the scope of the survey and detailed analyses of the first year's data are contained in a paper, "Weight and Height of a Population in 1943", by W. F. F. Kemsley, which appeared in the *Annals of Eugenics* (vol. 15, Part 2, 1950).

Food production and consumption.—Two very important weapons which the food statistician frequently needs are (1) an index of food production, and (2) an index of food consumption, not only for use separately, but also in combination.

Parts of the former have already been forged and several models of the latter have been produced, but no satisfactory method of combining the two has as yet been evolved.

An index of agricultural production is calculated by the Ministry of Agriculture and Fisheries and published in their *Agricultural Statistics*, the latest issue being *Agricultural Statistics U.K.*, Part II, H.M.S.O., 1949, covering the period 1939–40 to 1945–46.

By valuing at constant prices all farm and horticultural products, taking into account changes in value of crops and livestock held on the farm, and making deductions for intermediate products (feeding-stuffs, home-produced and imported) and imported store cattle and seeds, the value of net output can be obtained (Table 23), which is also shown in index form (pre-war average = 100) on page 27.

This fails to provide an index of production of food for consumption on two accounts. It includes (*a*) non-food products, e.g., wool clip, and (*b*) "Changes in Inventories," which, while rightly included in an index of agricultural production, are not appropriate for an index of production for consumption. However, adjustments to arrive at an index of food for consumption could easily be made.

The Interim Index of Industrial Production is designed to produce a prompt monthly index, and only purports to measure industrial production. It does not cover agriculture, forestry, fishing, transport, distribution, other sections of commerce or private or public services. The objects of this index, the production series used and in particular the difficulties encountered in determining weights for this index with no Census material more recent than that of the Census of Production, 1935, available, are set out in *The Interim Index of Industrial Production*, (H.M.S.O., 1949).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Within this index, food processing and manufacturing industries have a weight of 60·5 per thousand, drink and tobacco have a weight of 46·6 per thousand, making a total for the food, drink and tobacco group of 107·1 per thousand.

The index purports to measure net output, while the production series used generally refer to gross output. It is assumed that changes in gross output are proportional to changes in net output. Various admittedly rather arbitrary assumptions were made in determining the net output in the base year 1946, and while the resulting figures are doubtless adequate for use as weights in the index of industrial production, the estimates made would have to be looked at again before deciding on the appropriate weights for industrial production of food.

Changes in food consumption.—Various methods have been devised for measuring changes in food consumption. An index can be obtained for measuring changes in food consumption per head based on the daily calorie intake. Another index can be obtained of national food consumption by valuing food expenditure at constant prices. This is discussed in Section IV.

The former has the advantage that the unit (the calorie) is constant throughout, but has the disadvantage that it is only a very partial measure of the value of the food to the consumer.

The latter suffers from the usual index number difficulty in that when taken over a long spell of time the nature of the contents of the parcel measured changes, particularly in the quality of the items, so that one is no longer measuring the same thing at the end of the span of time as at the beginning.

Dependence on imports.—Research workers in the field of economics frequently look for some measure of the degree of dependence of the United Kingdom on imported foodstuffs. Up to now the only measure used officially, e.g., in replies to Parliamentary Questions or in the Economic Survey for 1949, has been the energy value or other nutrient (protein, fat) in the foods moving into consumption. The energy value of each food moving into consumption is apportioned between home production and imports in proportion to the supplies of food during the period concerned, and the totals for all foods give the proportions home-produced and imported. The table below shows these calculations for calories, fat and protein (animal and vegetable separately) for a number of years.

Contribution of Home Production to Food Supplies:

Nutrient equivalent of food consumption per head per day

			Pre-war	*1943*	*1948*	*1950/51*
Calories:	Total		3,000	2,860	2,890	2,990
	Home production		940	1,280	1,080	1,250
	As percentage of total		31	45	37	42
Fat:	Total	(g.)	130·2	115·3	107·6	128·7
	Home production	(g.)	42·7	34·7	38·8	46·5
	As percentage of total		33	30	36	36
Protein:	Total	(g.)	79·9	85·3	87·5	85·8
	Home production	(g.)	36·0	46·3	42·8	48·0
	As percentage of total		45	54	49	56
	Animal	(g.)	42·7	39·8	41·1	43·9
	Home production	(g.)	26·7	22·7	27·5	31·2
	As percentage of total		63	57	67	71
	Vegetable	(g.)	37·2	45·5	46·4	41·9
	Home production	(g.)	9·3	23·6	15·3	16·8
	As percentage of total		25	52	33	40

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Home production in this context covers agricultural production and British landings of fish and marine oils. A percentage to cover agricultural production only can, however, be very easily calculated.

The chief deficiency of this method is that it takes no account of our dependence upon imported feeding-stuffs.

It has the merit, however, of starting realistically with food *consumption*. Other methods, starting with supplies, can lead to conceptual difficulties. For instance, a country may produce more than enough to meet its requirements of one type of food and less of another. It balances supplies against requirements by exports and imports. Whatever common denominator is used to add the various types of food together, if the country is a heavy exporter of food, say, the value of home production may well be 100 per cent. or more of food consumption. Care must be used not to interpret this as meaning that the country is exactly or more than self-sufficient.

Another method of measuring the degree of self-sufficiency is occasionally found, that of comparing the number of acres in the country devoted to food per head of population with the number of acres required to supply the food consumed per head of population. This method is open to the objection just mentioned as well as to many others. For instance, it ignores such potential foodstuffs as fish and whale oil, which are not harvested from "acres". The number of acres to produce a certain quantity of wheat, say, varies from country to country, and if the food is not grown at all in the country but is wholly imported, which supplying country's "acres" should be used?

Other attempts have been made using money value as the common denominator. One soon runs into various difficulties. In selecting values per unit should one use the prices for home-produced or for imported commodities, both of which may conceal subsidies or taxes? Prices can change with startling rapidity. Imports may include highly manufactured foods, and if the contribution of imports is credited with the added cost of manufacture it will be unfairly weighted as against agricultural production.

The lesson is that in this field no single measure of the relative contribution of home production and imports is really satisfactory. Each must be taken on its merits and demerits, and the path of safety lies in never quoting a percentage without the qualification that the method used is only one of many.

IV. *National Expenditure on Food*

Pre-war estimates of national income almost always approached the problem from the income side, and built up aggregates from such data as Inland Revenue returns and statistics of wages and earnings. It was not until 1931 that a start was made on an independent determination from the expenditure side when Mr. A. E. (now Sir Albert) Feavearyear published his estimates of the national expenditure for the years 1924–27. In March, 1934, he published estimates of expenditure for the year 1932. (See *Economic Journal*, March, 1931, and March, 1934.)

The volume of information now available on quantities and prices is much greater, and these are combined to form the estimates of the national expenditure on food which are given in the annual series of White Papers, *National Income and Expenditure in the United Kingdom*. The basic data on food to be found in these papers are estimates of personal expenditure on food in household (divided into 10 food groups), and an estimate of expenditure by catering establishments and institutions on the food which they serve. It will be seen that this definition of personal expenditure on food is not one which would occur to the man in the street, as personal expenditure in catering establishments is spread over such items as rent, household goods and other services, and only the cost of ingredients is allocated to the food heading of the expenditure tables. The "other personal expenditure on food", which represents caterers' purchases, is not readily identifiable as an item of expenditure by individuals, and it can be misleading to add allocations of the amount to the ten food groups for which household expenditure is shown if the resultant totals are viewed as consumer expenditure. The estimated expenditure on food by caterers is built up from the individual foods, and it is therefore possible to allocate "other personal expenditure" after making some allowance for the difference between retail prices and caterers' purchasing prices to obtain an estimated retail value of civilian food consumption (as opposed to consumer expenditure on food) for the 10 groups.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The food group is the largest single group in the expenditure tables, representing 28·3 per cent. of the total, at current market prices, in 1949, and 30·3 per cent. in 1938. The individual items included in the food estimates are subject to different margins of error, depending on the amount and quality of the information upon which the estimates are based. As will be seen from the notes relating to the table of personal expenditure in the White Paper, the figures are compiled in relation to some ninety commodities or groups of commodities, and for some of them, particularly the smaller ones, the relative error is bound to be appreciable. The main purpose, however, is to provide an estimate of total expenditure on food, and in this context the errors involved are much less significant. It is nevertheless necessary to amend past estimates from time to time in the light of information which has become available later. It is perhaps interesting to note that for a recent year 8 per cent. of the total expenditure on food was attributable to items which individually did not represent as much as one half of 1 per cent. of the total. A further 10 per cent. was attributable to items which each represented less than 1 per cent. of the total.

For most of the major commodities, and particularly for those foods which are rationed, the estimates can be regarded as accurate to within narrow limits. Foods which were controlled during the war but which are now completely decontrolled are probably subject to a somewhat larger error in the more recent years. Unfortunately, some commodities, including one or two of the largest, raise particular problems which limit the accuracy of expenditure estimates. In particular the difficulties in assessing supplies of fresh fruit and vegetables for human consumption are very great, and it is unfortunate that this is in a group of foods whose value (excluding potatoes) is estimated at as much as 11 per cent. of the total for all food.

Estimates for purchases of bread, flour and cakes are closely inter-related, and are based primarily on the estimated analysis of utilization of the known quantities of flour delivered by millers. Underlying this analysis is information on bakers' claims for subsidy payments; the production trend for a panel of bakers and for a sample of flour confectioners; household purchases of flour as revealed by sample surveys and returns of flour usage by food manufacturers. Data for other cereal products are based on manufacturers' statements of production and distribution and net imports.

The estimates for meat products are based on issues of meat to meat manufacturers and the butchers' manufacturing allowance of rationed meat. This quantity is divided after deduction for canning so as to provide quantity estimates for sausages, meat pies and open pack products in the proportion indicated by housewives' purchases revealed in the household food survey.

Estimates of commercial supplies of fresh fruit are based on estimates of home production and imports, allowance being made for wastage and for quantities used by food industries. For fresh vegetables a different method has to be used. The staple vegetables such as cabbage and root crops are also used as animal food. The substantial fluctuations in crops from season to season are to a large extent absorbed in the margin, which represents the excess over requirements for civilian consumption. It is therefore necessary to estimate consumption on the basis of such limited information as is available on supplies moving off farms and of consumer purchases reflected in household surveys.

For most other commodities consumption data arise as a by-product of control or are provided by manufacturers in regular statistical returns. Where the collection of returns is impossible estimates of purchases of ice cream, for example, can only be based on the quantities of raw materials, in particular sugar, made available to producers.

A considerable amount of price data necessary for the compilation of the expenditure estimates is derived from price control regulations, which fix prices (as for rationed meat) or which prescribe maximum prices. While it is reasonable for some commodities to assume that the maximum prices usually operate, it would be quite unreasonable to do so for, say, fresh fruit and vegetables, and therefore a survey is taken each week of prices of these commodities in a sample of a thousand or more shops throughout Great Britain. While the selection of shops is as representative as can be arranged, the sample is to some extent dictated by the resources available within the Regional Organization of the Ministry. As the sample is not random, the quotations for individual varieties in any one week are subject to a margin of error which cannot be measured. However, the overall price of all vegetables weighted according to the relative importance of each type and also for weekly fluctuations in supplies as indicated by quantities moving through the main wholesale markets is thought to be fairly reliable.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Commodities such as cereal breakfast foods are generally sold at the maximum prices prescribed by manufacturers, and these are weighted in accordance with the quantities of each variety distributed.

Other cereal products, canned and bottled foods, preserves and a few other minor foods are priced on the basis of selected varieties and brands with the help of price lists made available to the Ministry.

The prices of bread, flour and cake and of meat products are derived from the Ministry's Household Food Survey, changes in price depending not only on the general trend but upon the balance of varieties (e.g., the proportion of self-raising flour and plain flour in the housewife's purchases).

Reference has already been made to the difference between the estimates of expenditure on food and the expenditure of the man in the street which arises because of the method of evaluating consumption in catering establishments. There are two further causes for the difference. Personal income as estimated in the White Paper on National Income and Expenditure includes income from farming. In so far as farmers consume some of their own produce the estimates of farm income are higher than farmers' money income. It is therefore necessary to include in the food expenditure estimates as a contra-entry the value at ex-farm prices of farm produce consumed by producers. The main products involved are milk, eggs, bacon and potatoes.

The estimates of personal income also include exchequer payments to individuals or in respect of personal goods and services when such payments do not influence the producers' remuneration. These transfer payments are differentiated from subsidies which do not appear either as income or expenditure in the Revenue Account of Persons. It is characteristic of these transfer payments that they benefit only a defined section of the community (e.g., old age pensioners, unemployed persons, etc.). It is necessary to include a contra-entry under the expenditure headings for various goods and services, and the food estimates include the transfer payments in respect of the Welfare Food Scheme (orange juice, cod liver oil, etc.), the National Milk Scheme and the Milk-in-Schools Scheme.

The White Paper on National Income provides an estimate of the disposal of economic resources in the provision of consumer goods and services. The estimates are obtained by adding to the detailed personal expenditure estimates the excess of subsidies over indirect taxation attributable to each category of expenditure. The main subsidies are payable in respect of food, whereas the only taxation on food is covered by customs duties and excise duty as on sugar and allied products. The food estimates for 1949 were increased by some 15 per cent. by the addition of the net balance between subsidies and taxation. On the other hand, the factor cost of other consumer goods and services was much below the consumer cost because of the large deductions in respect of beer and spirits duties, tobacco duties, purchase tax, entertainments tax, motor vehicle and other duties. In 1949 the factor cost of all consumer goods and services was 17 per cent. (£1,440 million) less than the current market value, whereas the factor cost of food was 15 per cent. (£354 million) more than the market value. Food accounted for nearly 40 per cent. of the national resources devoted to the provision of consumer goods and services, whereas it represented only just over 28 per cent. of personal expenditure on consumer goods and services.

For the purposes of calculating the factor cost of food the subsidies taken are the net trading losses in respect of food consumed during the period (and not the balance of receipts and payments during the period). The subsidies are adjusted in respect of non-food items such as flour used for industrial purposes and sugar used for brewing. The subsidies will not correspond in coverage with the trading loss of the Ministry of Food, but will include such payments as fertilizer subsidies and acreage payments borne on the vote of other Government Departments, but which contribute towards the stabilization of food prices. On the other hand, certain payments to farmers such as the Hill Sheep Subsidy which are not food subsidies but instruments of agricultural policy are excluded from the food calculations. Transfer payments referred to previously and included in personal expenditure are, of course, excluded from subsidies for the calculation of factor costs.

The third item of detail relating to food which is published in the White Paper on Income and Expenditure is the re-valuation of current purchases at prices relating to a previous year. The two years which have so far been used as base periods are 1938 and 1948.

These re-valuations used as the basis for a price index give rise to all the problems, and have all the disadvantages of a Paasche (current weighted) price index. In the first place the index

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

cannot be compared as between different periods because of the changes in weights. The change was sufficient to show a difference of one full point in an index (1948 = 100) for prices in one weighted alternately according to supplies in two recent succeeding quarters.

Secondly, for price rises in free market conditions the Paasche index tends to be lower than the Laspeyres because demand tends to move towards commodities for which price rises lag, and as a result these commodities have increasing weight in the index. Thirdly, there is the problem of new commodities which have no base-date price and for which a nominal base must be devised, possibly by reference to the nearest comparable food. Examples of such food commodities are dried egg and whalemeat.

Another difficulty is that re-valuation takes no account of changes in quality within a food item as defined for the purposes of the estimates. Thus one is compelled to assumed that cake in 1945 was the same commodity as cake in 1938, as there is insufficient information to permit an allowance for changes in the proportion of plain buns to cream cakes. Insufficiency of information is not the only problem, as it would take considerable boldness to pronounce on the aspect of quality to be measured and the relationship between bread made from flour of 72 per cent. extraction and of 85 per cent. extraction.

In comparing the current expenditure revalued at base prices with the base year expenditure to arrive at a Laspeyres (base-price-weighted) quantum index it should be remembered that no allowance has been made for population change. An index of 102 per cent. (1938 = 100) for food in 1948 as in table 18 of Cmd. 8203 is often misunderstood, and taken to mean that "food consumption is 2 per cent. higher" even for the individual, whereas the 2 per cent. may not have been sufficient to provide unchanged supplies for the increased population.

Clearly the difficulties associated with the Paasche price index must also influence the derived quantum index. The problem of quality already referred to is one of these, for a change in purchasing habits from purchases of flour, fats, sugar and dried fruit in the base year to a purchase in the current year of the same amounts of these foods in the form of cake at perhaps three times the cost of the ingredients would reflect itself in a rise in the quantum index. A change from more expensive foods such as dairy produce to cheap foods such as bread and potatoes would reflect itself in a fall in the quantum index. The meaning of a quantum index so derived is, therefore, so complex as to make it practically unintelligible, and there are many possibilities of its misinterpretation.

A Laspeyres (base-quantity-weighted) price index has attractions, because it would be comparable from period to period, and it would be much easier to retain some measure of stability of quality within the index.

APPENDIX

Processed and Manufactured Foods on which Statistics became available through War-time Controls*

Cereal breakfast foods.
Barley products.
Custard and blancmange powders.
Macaroni and similar products.
Canned soups.
Soft drinks in solid, semi-solid and powder form.
Flavouring compounds.
Potato crisps.
Fruit curd.
Mincemeat.
Syrup and treacle.
Mustard.
Yeast.
Malt vinegar.

* Other than those referred to in the text.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Spirit vinegar.
Non-brewed condiment.
Sausage seasonings, stuffings and forcemeat.
Gravy powder, browning and salts, soup mixtures and edible extracts.
Table jellies.
Coffee essence, coffee extract and coffee and chicory extract.
Shredded suet.
Infant and invalid foods.
Flour mixtures.
National milk cocoa.
Canned sweet puddings.
Dried pulses.
Imported honey.
Imitation honey.

Bibliography

The Brewers' Almanack. London: Review Press, Ltd.
FEAVEARYEAR, A. E. (1934), "The national expenditure, 1932", *Econ. J.*, **44**, 33
—— (1931), "Spending the national income", *Econ. J.*, **41**, 51.
International Sugar Council (1937 onwards), *Monthly Statistical Bulletin.*
—— (1947) onwards, *Pocket Sugar Year-book.*
KIRK, J. H. (1945), "The output of British agriculture during the war", *J. Proc. Agric. Econ. Soc.*, **7**, 30.
Milk Marketing Board (1939), *Milk Marketing Scheme : Five Years' Review, 1933-39.*
—— (1944 onwards), *National Milk Records : Annual Report England and Wales for Year ending 1st October, . . .*
Northern Ireland : Ministry of Commerce (1937), *Reports on the Sea and Inland Fisheries of Northern Ireland for 1935 and 1936.* Belfast : H.M.S.O.
Potato Marketing Board (1936-1938), *The Area under Potatoes in Great Britain.*
—— (1934-1939), *Report on the Operation of the Potato Marketing Scheme.*
Scotland : Fishery Board (1938), *Sea Fisheries Statistical Tables.* Edinburgh : H.M.S.O.
STONE, J. R. N. (1945), "The analysis of market demand", *J. Roy. Statist. Soc.*, A, **108**, 286.
United Kingdom : Central Statistical Office (1941-1945), *An Analysis of the Sources of War Finance and Estimat of the National Income and Expenditure . . . 1938 and 1940—1938-1944.* Cmd. 6261, 6347, 6438, 6520, 6623. London : H.M.S.O.
—— (1948 onwards), *Annual Abstract of Statistics*, No. 84, onwards. London : H.M.S.O.
—— (Jan., 1946 onwards), *Monthly Digest of Statistics.* London : H.M.S.O.
—— (1951), *Monthly Digest of Statistics : Supplement, Definitions and Explanatory Notes.* Revised January, 1951. London : H.M.S.O.
—— (1946-1951), *National Income and Expenditure of the United Kingdom, 1938* to *1945—1946* to *1950.* Cmd. 6784, 7099, 7371, 7649, 7933, 8203. London : H.M.S.O.
United Kingdom : Commonwealth Economic Committee (1950), *Dairy Produce : A Summary of Figures of Production, Trade and Consumption . . .* London : H.M.S.O.
—— (Jan., 1948 onwards), *Intelligence Bulletin.* London : H.M.S.O.
—— (1938), *Meat : A Summary of Figures of Production and Trade . . .* London : H.M.S.O.
—— (1948, 1950), *Meat : A Summary of Figures of Production, Trade and Consumption . . .* London : H.M.S.O.
—— (1948, 1950), *Plantation Crops : A Summary of Figures of Production, Trade and Consumption . . .* London : H.M.S.O.
—— (1948), *Vegetable Oils and Oilseeds : A Summary of Figures of Production, Trade and Consumption . . .* London : H.M.S.O.
United Kingdom : Customs and Excise Department (monthly), *Accounts Relating to the Trade and Navigation of the United Kingdom.* London : H.M.S.O.
—— (1951), *Annual Statement of the Trade of the United Kingdom . . . 1948 . . .* 4 v. and supplement. London : H.M.S.O.
—— (1951), *Report of the Commissions of H.M. Customs and Excise for the Year ending 31st March, 1950 . . .* London : H.M.S.O.
United Kingdom : Herring Industry Board (1938), *Third Annual Report for the Year ended 31st March, 1938.* Cmd. 5762. London : H.M.S.O.
United Kingdom : Imperial Economic Committee (until 1939), *Dairy Produce Supplies.* London : H.M.S.O.
—— (1938), *Meat : A Summary of Figures of Production and Trade.* London : H.M.S.O.
—— (1935, 1938), *Plantation Crops : A Summary of Figures of Production and Trade . . .* London : H.M.S.O.
—— (May 24th, 1929–September 1st, 1939), *Weekly Dairy Produce Notes.* London : H.M.S.O.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

United Kingdom : Livestock Commission (1938), *First Report*. London : H.M.S.O.
United Kingdom : Ministry of Agriculture and Fisheries (1947), *Report of the Committee Appointed to Review the Working of the Agricultural Marketing Acts*. (Economic series no. 48.) London: H.M.S.O
—— (1938), *Sea Fisheries Statistical Tables*. London : H.M.S.O.
United Kingdom : Ministry of Agriculture and Fisheries ; Department of Agriculture for Scotland ; Ministry of Agriculture, Northern Ireland (1947 onwards), *Agricultural Statistics*, 1939-1944; *United Kingdom*. Part I. London : H.M.S.O.
—— (1949 onwards), *Agricultural Statistics : United Kingdom. Part II*. London : H.M.S.O.
United Kingdom : Ministry of Food (1944), *Food Consumption Levels in the United States, Canada and the United Kingdom* . . . London : H.M.S.O.
—— (1947), *Food Consumption Levels in United Kingdom*. Cmd. 7203. London : H.M.S.O.
—— (1949), *Food Consumption Levels in United Kingdom*. Cmd. 7842. London : H.M.S.O.
—— (1946), *How Britain was Fed in Wartime : Food Control* 1939-1945. London : H.M.S.O.
United Kingdom : Sugar Commission (1937 onwards), *Report of the Sugar Commission for the Year ended 31st March* . . . London : H.M.S.O.
United Kingdom : Wheat Commission (1938), *Report on Administration of Wheat Act, 1932, from June, 1932, to 31st July, 1937*. London : H.M.S.O.
United Nations : Organisation for European Economic Co-operation (1950), *Food Consumption Levels in O.E.E.C. Countries*. London : H.M.S.O.
United States of America : Department of Agriculture (1944), *Food Consumption Levels in the United States, Canada and the United Kingdom : Second Report*. Washington.
—— (1946), *Food Consumption Levels in the United States, Canada and the United Kingdom : Third Report*. Washington.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—*Finney* (*D. J.*). Statistical Method in Biological Assay	85
2.—*Rao* (*C. R.*). Advanced Statistical Methods in Biometric Research	86
3.—*Hald* (*A.*). Statistical Theory with Engineering Applications	87
Hald (*A.*). Statistical Tables and Formulas	87
4.—*Tippett* (*L. H. C.*). Technological Applications of Statistics	88
5.—*Bowley* (*Sir A.*). An Elementary Manual of Statistics. 7th ed.	89
6.—*Lambe* (*C. G.*). Elements of Statistics	90
7.—*Mainland* (*D.*). Elementary Medical Statistics	90
8.—*Neyman* (*J.*). (Ed.). Lectures and Conferences on Mathematical Statistics and Probability. 2nd ed.	91
9.—*Hartree* (*D. R.*). Numerical Analysis	92
10.—*Stone* (*R.*). The Role of Measurement in Economics	92
11.—*Hicks* (*J. R.*). The Social Framework. 2nd ed.	93
12.—National Bureau of Economic Research. Conference on Research in Business Finance	94
13.—*Adler* (*J. H.*). The Pattern of United States Import Trade since 1923	95
14.—Milbank Memorial Fund. Approaches to Problems of High Fertility in Agrarian Societies. Papers. 1951 Annual Conference	97

1.—*Statistical Method in Biological Assay.* By D. J. Finney. London: Griffin, 1952. xx + 661 pp. 9″. 68*s*.

During the last 20 years the methods used by pharmacologists and others to estimate the potency of drugs have been attracting the attention of increasing numbers of statisticians, and several books on the subject have been written. Dr. Finney, who is one of the leaders in this field, has now written the largest and most complete textbook on biological assay which has so far appeared. It is intended for four main classes of reader—the professional statistician desiring a short course in biological assay, the non-mathematical user of biological assays, the reader who requires a general survey of the function of statistical science in biological assay, and the reader mainly interested in quantal responses. Appropriate courses of reading for these four groups are suggested at the beginning of the book. Some general knowledge of statistics, including such things as the analysis of variance, is assumed, but all the special methods used in bioassays are described in full with examples, and the necessary special tables are given. The main purpose of the book appears to be didactic; it is a guide for the future rather than a survey of the past, but controversial points are fully discussed and the bibliography includes 266 items.

The book starts with an introduction which explains biological assays for the benefit of mathematical readers and gives a table of the notation adopted. As the author points out, the great variety of notation used in the literature of bioassay is a source of confusion to the reader. Most of the symbols are given their usual meanings here, but this is not always so. The symbol I was used by Bliss and Marks in 1939 to denote the interval between successive log doses. This usage has been widely followed and was adopted in the textbook by Emmens. Finney uses D for this purpose and gives new meanings to A, C and I. λ is generally used to mean the standard deviation of log tolerance or, wrongly, for estimates of this quantity. In the first edition of *Probit Analysis* Finney used it for the dose. In the second edition (p. 19) he appeared to repent, but in the new book he gives this symbol two new meanings and adds defiantly that he never uses it like other people. Such differences between writers are liable to confuse those who are not accustomed to the vagaries of mathematicians. The time has perhaps come when a committee should decide on a standard notation for bioassays.

The second chapter deals with direct assays, in which the effective dose for each animal is measured by slow administration. There are then 14 chapters on assays depending on measured responses and 5 chapters on quantal responses.

General principles are fully discussed, a variety of new and old experimental designs is presented and their advantages clearly shown. Methods are explained and examples are worked

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

out. Some of these methods are apt to appear unnecessarily laborious and complicated to the biologist, who would often prefer simple calculations giving 90 per cent. efficiency on 100 animals to complicated calculations giving 100 per cent. efficiency on 90 animals. As Dr. Finney points out in this book, the division of effort between observation and computation may depend on what is the most economical way of getting the required precision.

Some workers have avoided probits because of the complexity of the calculations, but this complexity is largely unnecessary. Dr. Finney gives several examples of iterative approximations, and in all of these the error which would be introduced by taking the first approximation is less than 1 per cent. of the inevitable fiducial range of the estimate. Such errors are negligible, especially as the result depends on the arbitrary assumption that $P = 0{\cdot}95$. This is typical of the benefits which come from iterative calculations, except in cases where the results are so odd that the experiment ought to be repeated. Iterative calculations are rarely useful, and should not be recommended for routine work.

The use of probits to calculate the results of assays based on quantal responses depends on the assumption that log tolerance is normally distributed. Dr. J. Berkson has advocated the use of a slightly different assumption which leads to practically the same result, and Dr. Finney discusses this proposal with unexpected patience and at unnecessary length. Berkson's method assumes that the log-dose-percentage curve is logistic, and is advocated on the ground that logistic curves have been used successfully in physical chemistry. One well-known example is the curve showing the uptake of oxygen by haemoglobin and this depends on the following argument: Let y denote the proportion of receptors occupied by oxygen and let K_1y be the rate of dissociation. The proportion of free receptors will be $(1 - y)$; let $K_2x(1 - y)$ be the rate of combination, where x is the concentration of free oxygen. For equilibrium these quantities will be equal; the result of equating them is a simple logistic formula. Other curves can be predicted by assuming that several molecules of oxygen combine with each molecule of haemoglobin, as is in fact known to be the case. Similar arguments have been used to justify the use of this formula in connection with adsorption, and the combination of poisons with enzymes and drugs with isolated tissues. The use of this formula may perhaps be justified in these cases where equilibrium is reached, but it is not clear why the same formula should be applied to dose-mortality curves; it would be absurd to suggest an equilibrium between death and resurrection from the dead. It may be useful to have a method of fitting logistic curves accurately in cases where their use is justified by logic. There is no theoretical justification for fitting them to dose-mortality data, and this procedure would only be justified if it could be shown to save trouble; the evidence for this is not convincing.

Dr. Finney discusses this and many other questions. His book can be recommended as comprehensive and reliable.

J. H. GADDUM.

2.—*Advanced Statistical Methods in Biometric Research.* By C. Radhakrishna Rao. New York: Wiley (London: Chapman & Hall), 1952. xvii + 390 pp. 9″. 60*s*.

In view of the shortage of books on the more advanced statistical ideas Professor Rao's work is very welcome, especially since he has tried to present his material in such a way that the applied statistician will be able to use the methods given and the mathematical statistician will be able to study their mathematical bases. Indeed, a merit of this book is the excellence and quantity of the examples which are worked out for the benefit of the reader, and though most of these are from anthropometry they demand no technical knowledge of that subject, so that even a mathematician, such as the reviewer, can understand them.

After an extremely rapid survey (74 pages) of such parts of matrix algebra and distribution theory as he needs, Rao begins the statistics proper with a chapter on the theory of linear estimation and tests of hypotheses (54 pages), in which least squares theory is developed by means of the matrix theory given earlier, and applied to analysis of variance and related problems. There follow a chapter on maximum likelihood (47 pages) and two on χ^2 tests, transformations and tests for homogeneity of variances and correlations (60 pages). After a rapid survey of multivariate analysis in 37 pages the book concludes with two chapters, totalling 106 pages, on some work of the author on classificatory problems and the concept of group distance. We are all entitled to our own pet subjects, but perhaps these last two chapters, over a quarter of the book, are rather out of proportion. Apart from this the topics are well chosen, and the ideas emphasized are usually the important ones. Perhaps the most stimulating feature of the book is the command which the author has over the statistical methods, and the apparent ease with which he is able to handle large quantities of data and subject them to analysis.

It is a pity that with such excellent material at his disposal the exposition should be so unsatisfactory. The reviewer gets the impression that the book has been much too hastily written:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

not nearly enough care has been devoted to the relationship between the parts, and details of the discussion are often confusing. There are many examples of this; perhaps the most glaring is the relationship between the theory of the third chapter (on least squares) and the applications to the analysis of variance. It would have been most helpful if the observational equations had been written out, the normal equations solved and the tests introduced in strict parallel with the theory in at least one case. The computation of the interaction sum of squares in a two-way classification (pp. 95–100) was particularly confusing. Even in the mathematics the reviewer found the style unnecessarily perplexing and often irritating. For example on page 33 appears the sentence, "Thus the sum of two binomial variates is also a binomial variate," and on p. 36 we are informed "that the sum of k Poisson variates, each with parameter μ, is itself a Poisson variate." The first statement is only true for binomial variates with the same p, and the latter does not need the restriction to equal values of μ. The fact that these statements are corrected on p. 37 hardly makes for clarity. Some of the mathematical proofs are unnecessarily complex and laboured.

It is inevitable that many errors are present in a treatment of this type. Most of these are minor, but a few are more serious. The definition of a partial correlation coefficient (p. 69) is incorrect, as is the definition of a minimal set of sufficient statistics (p. 144); the correct definition of the idea behind the latter has been given by Lehmann & Scheffé (Sankhyā (1950), **10**, 311). Fiducial intervals are confused with confidence intervals (p. 276). The distance function on p. 352 is such that the distance between identical points is non-zero, and is therefore not acceptable. Furthermore in a discrimination problem involving two hypotheses equating the two errors and minimizing their common value is not equivalent to making the least possible proportion of misclassifications (p. 352). A detailed criticism of the author's classification methods will appear elsewhere (Lindley, *J. R. Statist. Soc.*, B, 1953).

An attempt has been made to introduce a unity into the computational methods employed by using the device of reducing a matrix by pivotal condensation wherever possible. The recognition that so many statistical methods consist in matrix reduction is important, but the use of pivotal condensation to carry out the reduction is questionable. The matrices which arise in statistical work are usually symmetric and positive definite, and for such matrices a method of reduction based on triangular resolution is preferable. The methods given by Fox and Hayes (*J. R. Statist. Soc.*, B (1951), **13**, 83–91) can hardly be improved upon: there is only one operation (apart from a few square roots to be looked up) to be learnt, and this is used over and over again, the writing is reduced to a minimum, and the errors, judging from the reviewer's experience, are far less than in other methods. It is a curious fature of Rao's computations that a very large number of decimal places is used. Perhaps this arises from the use of pivotal condensation methods, and could be avoided by triangular resolution.

This book is not likely to be very valuable for students in view of the weaknesses in style, but research workers with some knowledge of the methods discussed and the patience to follow Rao's terse remarks will benefit from the ideas he introduces. D. V. LINDLEY.

3.—*Statistical Theory with Engineering Applications.* By A. Hald. New York: Wiley. London: Chapman & Hall, 1952. xii + 783 pp. 10″. 72*s*.

Statistical Tables and Formulas. By A. Hald. New York: Wiley (London: Chapman & Hall), 1952. 97 pp. 11″. 20*s*.

"Using only standard differential and integral calculus, Dr. Hald presents the statistical methods important to the engineer in his daily work." This summary led the reviewer to expect a simple exposition of fundamental principles with detailed discussion of practical applications in engineering. Yet the book is not this; it is a treatise, written in the language of mathematical statistics, which includes a thorough discussion of the more important standard techniques of statistics and of quality control, together with an outline of the scope of many more advanced topics; and it is illustrated throughout with numerical examples drawn from a wide variety of industrial fields.

An introduction to the calculus of probabilities leads to an elementary treatment of the binomial and kindred distributions. This is followed by a discussion of empirical distributions, including graphical representation, mean and variance, expectation of a function, and two-dimensional distributions. In the next few chapters the author discusses sampling distributions (notably of the mean, variance, and χ^2), estimation, and significance tests involving means and variances. We are then reminded of the industrial terms of reference by a chapter each on the range and statistical control (including the theory of runs), and subsequently return to standard techniques again with the variance ratio, Student's t, and the analysis of variance. This group of chapters is nicely rounded off by a chapter on stratified sampling and experimental design. Three chapters are devoted to simple and multiple regression and correlation, one each to a more advanced treat-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ment of the binomial, Poisson, and multinomial distributions (including tests of goodness of fit), and one to sequential analysis. The final chapter contains advice on the carrying out of a statistical analysis in practice.

Such a sketchy outline does no more than indicate the broad plan of the book; there are upwards of two hundred chapter sub-headings, almost every one of which gives a usefully complete treatment of a distinct statistical topic, such as an aspect of a standard technique, a development arising out of a standard technique (e.g., the comparison of several regression lines, the comparison of truncated normal distributions, the inverse sine transformation of the binomial), or an outline of the scope of some specialized or advanced topic (e.g., time series, stochastic processes, systematic sampling). Except for the treatment of time series and the more elaborate aspects of experimental design, about which more might usefully have been said, the book is almost an encyclopaedia of the statistical techniques which are of proven or potential value in industry, or even in many other fields of application. Moreover, it gathers together the results of much recent research, and has an excellent collection of bibliographical references. The comprehensiveness of the cross references and prominent display of applicable formulae make it convenient as a reference book, though the notation (e.g., $\mathfrak{M}$ for the mathematical expectation operator) and language (e.g., fractiles for quantiles) are not always conventional.

The treatment, though descriptive in parts, is on the whole mathematical. While the kind of mathematics used is restricted, the amount is not; there are given many demonstrations by elementary but not always easy mathematics of properties which in most books are either taken for granted or established with the aid of advanced mathematics such as complex variable, generating functions, or higher geometry. Having a good deal of space at his disposal, the author gives all the steps in his mathematical arguments, and adds conviction to proof by illustration. Thus, for example, not only is it established that the normal distribution is a large sample approximation to the binomial, but the quality of the approximation is demonstrated for a number of binomial distributions, and guidance is given as to the sample size for which the approximation is adequate.

The claim that the methods given are important to the engineer in his daily work is exaggerated. All the technologists known to the reviewer would be horrified to think that they needed to know or use even the simplest tenth of the material given in the book. As a work of instruction, the book is too long and expensive, and there is so much discussion of ancillary topics that the novice will have his attention distracted from important fundamentals; furthermore, the engineer who wishes to know something of statistics needs fuller discussion of the applications of the simpler techniques. The real value of this book is as a work of reference on the theory of statistics, and as such its value will be considerable. It will doubtless eventually find its way to the bookshelf of almost every industrial statistician; and since most of its contents are of perfectly general application, it will be useful to other statisticians, too. As a source of useful illustrations and elementary mathematical proofs, it will be valuable to the teacher of statistics. It will be a blessing to the worker who wishes to know the scope of and justification for some advanced technique, but who recoils at the difficult mathematics in terms of which it has hitherto been presented.

The book of tables and formulas includes the most important formulas given in the text-book, together with a useful collection of tables to be used in connection with them. The latter includes the normal frequency and cumulative frequency functions; fractiles of the normal distribution and the distributions of χ^2, χ^2/f, the variance ratio, and the range of samples of up to twenty; the one-sided truncated and censored normal distribution; confidence limits for the expectation in the binomial; tables of the transformation 2 arcsin/X ; log $n!$; logarithms of binomial coefficients, squares, square roots, reciprocals, and four-figure logarithms; and random sampling numbers.

G. H. Jowett.

4.—*Technological Applications of Statistics.* By L. H. C. Tippett. London: Williams & Norgate, 1952. ix + 189 pp. 8½″. 15*s*.

This book is based on a series of lectures given by Mr. Tippett early in 1948 at the Massachusetts Institute of Technology. It makes no pretence of standing on its own, and is intended "as an introduction and companion to a systematic text-book or course of study in applied statistics". In this lies its chief value to students of all kinds, for although it makes constant use of many aspects of the theory, it does not attempt to give an outline of the theory and the reader is frequently advised to refer to appropriate text-books. While the book is obviously of great value to a technician in industry starting to study and to apply statistical methods, its value to the student of theory is equally important. Although the book makes no new approach to the development of theory it puts theory in the correct perspective.

In reading the first part of the book, on quality control, comparison with the many other books on the subject is inevitable. Unlike most of these Mr. Tippett's exposition is well balanced, with-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

out undue emphasis on any one type of method. The discussion covers such techniques as those developed by Stevens for control by gauging and Sealy's group control chart, and brings out clearly possible uses of these methods—uses which are often overlooked by the practitioner in quality control. This section of the book contains also an excellent exposition of the main techniques of acceptance and rectifying inspection. The value of this will be appreciated when it is realized that it must be one of the few places in the literature where all the important approaches to these problems are compared and contrasted. However, the book contains no tables or charts for devising actual schemes; for these the reader is rightly referred to the original literature.

In the chapters on the design of experiments and tests of significance the practical implication of the various theoretical interpretations are brought out with remarkable clarity. The situations in which data are collected with the form of their analysis in mind are contrasted with those cases where some form of analysis has to be applied to data already to hand. This is of particular interest to the industrial technician, for while the theoretician might insist that the collection of data should always be planned, the industrial statistician must often put up with what he can get. However, in keeping with the rest of the book these chapters can be fully appreciated only by those with some theoretical knowledge, and the deeper this knowledge the more valuable will these chapters prove.

The only complaint to be made about this book is that it does not deal with all those aspects of the subject on which the author's opinion would be of interest. It would have been useful to have had a rather lengthier discussion on the questions of costs affecting the choice of acceptance and rectifying inspection schemes. Further, in the section dealing with the analysis of variance more could have been said on the interpretation of and methods of dealing with interactions. Analyses involving quite high order interactions occur frequently in technological experiments, and the practical consequences of these, where they prove significant, are of great importance.

These defects are, however, slight, particularly when compared with the great merits of the book, and it will be surprising if the book did not take a permanent place in statistical literature and become a classic in its own field.

DENNIS NEWMAN.

5.—*An Elementary Manual of Statistics.*—By Sir Arthur Bowley, C.B.E., Sc.D. 7th ed. London : Macdonald & Evans, 1952. ix + 297 pp. $8\frac{1}{2}''$ 10*s*.

This elementary manual was first published in 1907 "for the use of those who desire some knowledge of statistical methods and statistical results without going deeply into technicalities or undertaking mathematical analysis". . . . "It is also designed as a first course in statistics for students who wish to proceed further in the subject and . . . will stimulate interest in the many fascinating problems that await solution and that can only be attacked by the methods of modern mathematical statistics." Looking back upon these extracts from the preface to that first edition the reviewer would note that the need still exists for more than one manual to encourage those who should know something of our national statistics and the proper methods for their manipulation. For the student the fascinating problems are still there, albeit somewhat changed owing to the enlarged horizons of statistical technique. Although he now has a longer road to travel than was possible nearly a half century ago, he will find that this new edition of Bowley's *Elementary Manual* will serve his early needs in just that same sturdy way. The first part of the book deals with those simple methods and other items from the statistical tool-box which are indispensable to the handling of data collected on a large scale. The slight excursions into elementary algebra should in no way disturb the business man or interested citizen. Indeed, as against the experts, Sir Arthur provides them with a nicely calculated position. His comment (preface to 6th edition) that "the correlation coefficient (and) the method of least squares are dangerous weapons except in the hands of the expert" permits them to adopt the right approach and consult the expert rather than to dabble in these matters themselves. The last two chapters in this part dealing with "Rules for using Published Statistics" and "Methods of Statistical Analysis"—the latter applied to three common problems in descriptive statistics—contain truths which are all too frequently overlooked in these days of statistical tools which are sometimes too sharp for the available data.

The second part of this book is devoted to descriptions of the main body of official statistics. In order that this shall still be an acceptable guide to modern official statistics, and to take account of the vast changes in both content and organization in this field since 1938, an Appendix has been added in this seventh edition in place of those appearing in earlier editions. The new appendix gives relevant material for the years 1938 to 1947–50, thus affording the reader a remarkable conspectus of the principal trends in British official statistics over half a century. Naturally such a survey can never be completely up-to-date owing to the time-lags in publication. Further improvements have taken place in the last eighteen months—as witness the transition of the erstwhile annual White Paper on National Income to the status of a Blue Book. It would therefore be

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

unfair to point out this or that small omission. But at the risk of appearing discourteous or even parochial, the reviewer regrets the absence of the new "Transport Statistics" of the British Transport Commission, since this is the only main topic where the treatment in Part II of the text is not matched by appropriate extensions in the Appendix. Some re-consideration of this field might have led to the withdrawal of the footnote on page 91, since in this respect, at least, the railway statistician seems to have made some progress.

Teachers, particularly those in evening institutes or connected with other forms of adult education, will be glad to have this new edition of an old favourite. Its continued influence should do much to spread the idea of the statistical approach to problems of modern society.

W. R. BUCKLAND.

6.—*Elements of Statistics.* By C. G. Lambe. London: Longmans, Green, 1952. viii + 112 pp. $8\frac{1}{2}''$. 8*s.* 6*d.*

The author attempts in a little more than one hundred pages to cover certain fundamental concepts of statistical theory and some of the elementary techniques of statistical method. The examples used are drawn from a wide field, but their chief use is to illustrate arithmetical manipulation of data rather than to give an idea of the practical implications of the statistical measures obtained as a result of the calculations. This emphasis on computation persists even in the numerous examples given at the end of each chapter; these, although using data from many fields, never require more of the student than accurate arithmetic.

In the first paragraph the subject is divided into five "parts"; while this division may seem natural enough to the author it is doubtful whether many statisticians would agree with it, even assuming it were clear what each heading is intended to cover. The subsequent argument does not clarify this treatment, and it is at no time certain which of his five "parts" the author is discussing. Consequently it is difficult to detect any underlying plan of development.

The book contains a number of doubtful proofs, such as that of the Poisson distribution as the limiting form of the Binomial distribution (p. 39), and that of what is presumably intended to be Laplace's theorem (p. 49). It is difficult to understand why these have been included in a book which makes no pretence at theoretical completeness, particularly since the full practical importance of these theorems is never clearly brought out. In addition there are many statements which will surprise most practising statisticians; for instance on p. 49 reference is made to "the theory of errors or, as it is often called, of estimation", while on p. 93 we learn that quality control "can be usefully applied . . . to investigations in any scientific field". The terminology used is not always standard. For instance on p. 2 the word "trend" is used in a sense which from the context must be different from that in which it is generally used, but the meaning to be attached to it is by no means clear.

Indeed the book is remarkable for the way it avoids giving specific definitions to the terms it uses, even those which are of fundamental importance in the subject. Thus, one is left in doubt as to what precisely the author means by such terms as "histogram", "frequency curves", "independence of variables", and "statistical control". The danger of this lack of clarity is that it would be easy to read into the book confirmation of many of the errors which to-day are unfortunately all too common among those students who have only a superficial reading of statistics and no practical experience. Beginners reading this book should be warned that the form of the normal curve on p. 26 is not strictly correct and could be confusing; that the logarithmic transformation on p. 62 is incorrect, and that it would be wrong to imply from page 99 that the Poisson distribution can only be used in quality control work when the expected number of defectives per sample is less than 10.

D. NEWMAN.

7.—*Elementary Medical Statistics. The Principles of Quantitative Medicine.* By Donald Mainland. Philadelphia: W. B. Saunders Company, 1952. x + 327 pp. $8\frac{1}{2}''$. 25*s.*

There are few books on statistical ideas and techniques which are specifically intended as an introduction to the subject for doctors or medical students, and Professor Mainland's book is written to meet that need. He rightly attempts to emphasize correct habits of thought and approach to medical statistics rather than the routine application of methods, which is too often regarded by students as the essential element in the appraisal of numerical data.

The author approaches the subject gently and at considerable length. An introductory chapter on "The place of statistics in medicine" is followed by one "On looking at evidence". The reader is urged to approach published work critically; the type of question which he should have in mind when appraising such work (and, by implication, in planning his own) is indicated, and a number of common pitfalls in the presentation and interpretation of data are described in detail. Chapter

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

III is concerned with inferences from a single sample of a binomial population, and Chapter IV with the comparison of two binomial samples, leading to contingency tables with more than two rows and columns. These four chapters occupy 146 pages—nearly half the text. Inferences from the mean of a single sample, and the comparison of the means of two samples, followed by a general discussion of the normal and *t*-distributions, occupy most of the 60 pages of the fifth chapter, which also includes a brief introduction to the analysis of variance. Correlation and regression, together with references to curvilinear and multiple regression, are outlined in a much shorter chapter, as befits subjects likely to be less often used by the beginner. The two final chapters contain a variety of miscellaneous topics under the general headings of "Statistical ideas in clinical practice" and "Some further hints for investigators". These largely consist of brief remarks on subjects which have not found a place in previous chapters, such as the standardization of rates and probit analysis, or expansions of subjects which were only mentioned briefly earlier in the book, such as errors in routine measurements and the analysis of variance. Chapters II to VI are each furnished with a set of practical examples; answers are given at the end of the book. There are two tables (and four charts) of binomial confidence limits, and tables of significance levels for χ^2 and for t.

The presentation of the material in this book seems to me too tenuous and disjointed (particularly in the chapters on the binomial distribution). For example, the scope and importance of vital statistics are first outlined after sections dealing with the breakdown of complex data into more homogeneous groups. The transition is quite abrupt, and it is not until the following page that the reason appears, namely, to point out the frequent need, in handling vital statistics, to break down the material so as to permit more precise comparisons. Further sections on vital statistics occur at least twice in widely separated parts of the book. This type of digression, the partial description of a separate subject to illustrate a particular point, is common. It necessitates numerous cross-references, and even instructions on how to read the various chapters.

A text-book, apart from being readable, should also be a book of reference. A further result of this informal presentation of the subject is that it is extraordinarily difficult for the reader to find a particular section again in order to re-read it, and when he succeeds, he can never be sure that he is reading all that the author has to say on that topic.

An immaculately set introductory page announces that the book—one of a series of medical monographs—has been produced with careful attention to excellence of illustration and legibility of type. The illustrations are good, but the text appears to have been photographed from typescript.

IAN SUTHERLAND.

8.—*Lectures and Conferences on Mathematical Statistics and Probability*. By Jerzy Neyman, 2nd ed., revised and enlarged. Washington, Graduate School, U.S. Department of Agriculture, 1952. vii+274 pp. 9¼″. 50*s*.

The first edition of this book was a mimeograph of the three lectures and six Conferences given at the Graduate School of the U.S. Department of Agriculture in 1937. It was exhausted within two years of publication. Since then the frequency of reference to the publication, especially concerning the theory of statistical estimation with which the author's name is associated, has led many research workers to regret that the publication was no longer available. The appearance of a new edition in printed book form will therefore be welcomed, and merits the serious attention of every mathematical statistician. Fifteen years have, however, elapsed, and there is little doubt that an ordinary reprint would nowadays be in some respects out of date. While retaining the general format of the original publication, therefore, (for example, questions interpolated by members of the audience, and replies thereto, are included), the material, as a whole, has been substantially revised, and indeed considerably enlarged. This means, among other things, that the current view-point of the author, particularly in relation to questions which have been the subject of controversy in the past, is presented. The author has not hesitated, in places, to modify his views to some extent, and even to own up occasionally to being wrong in his first understanding of the work of others, but what remains is essentially the Neyman theory as presented to the world in the 'thirties, and it is a good testimonial to the author's qualities that the statistical world in general has adopted his theories, and that his name stands among the foremost of the architects of mathematical statistics as we know it today.

Chapter I, dealing with the modern viewpoint on the classical theory of probability and its applications, and in particular with tests of statistical hypotheses, is based on the three formal lectures given in 1937. These are listed as Parts 1, 2 and 3. The material has been revised, as can be seen from the discussion of Jeffreys' *Theory of Probability* (published 1939) and of what are known as contagious distributions, with references to papers published during the war years. An

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

interesting feature is the ascription of the first exact test of a statistical hypothesis to Laplace in a paper published in 1773.

One Conference has been entirely left out, in view of the modern work on econometrics and stochastic processes. The remaining five are distributed between Chapters II (some controversial matters relating to agricultural trials), III (some statistical problems in social and economic research) and IV (statistical estimation). But in addition, Part 2 of Chapter III is a reprint of the author's 1938 paper in the *Journal of the American Statistical Association*, and Part 3, cast in lighter vein, is based on a talk given at Berkeley in 1947. Likewise Part 3 of Chapter IV is a reprint of the author's 1941 paper in *Biometrika* on fiducial argument and the theory of confidence intervals, and Part 4 is based on a lecture describing Charles Stein's sequential procedure given at University College, London, in 1950. The whole makes stimulating reading to-day, even if there are points on which the reader may feel like taking issue with the author.

J. WISHART.

9.—*Numerical Analysis.* By D. R. Hartree. Oxford: Clarendon Press, 1952. XIV + 287 pp. 9¼″. 30*s*.

"Numerical Analysis," a modern branch of applied mathematics, is the technique of evaluating numerically expressions defined by mathematical formulae, and the present book has been written by the leading authority in this country on the subject, and may be regarded as the first comprehensive text book summarizing modern developments. The scope of the subject, as defined on p. 4, embraces the following numerical operations: (*a*) Evaluation of formulae, (*b*) solution of non-linear equations in one unknown, (*c*) solution of systems of linear simultaneous equations, (*d*) inversion of matrices, (*e*) determination of characteristic values and characteristic vectors of matrices, (*f*) solution of systems of non-linear simultaneous equations, (*g*) tabulation of standard functions, (*h*) interpolation and subtabulation, (*i*) integration and differentiation of a given function, (*j*) smoothing, (*k*) integration of ordinary differential equations, (*l*) integration of partial differential equations, (*m*) solution of integral equations, (*n*) harmonic analysis, and (*o*) frequency analysis (periodogram analysis). Although some of these operations are clearly based on certain branches of the calculus, the mathematical apparatus is here deliberately restricted to results immediately useful for the task of numerical evaluation. On the other hand, there is a wealth of extremely sound advice on the practice of computing based on the author's 35 years of personal experience.

The methods described are largely those suitable in conjunction with desk calculating machines and mathematical tables—only one last chapter gives a brief summary of the functions of modern high speed automatic computors (relay or electronic) and a system for their programming. Those of us who are in the habit of rapidly checking simple computations to about two-figure accuracy on a slide rule may be disappointed that only two very specialized (if ingenious) auxiliary calculations are given as instances for its use in conjunction with a calculating machine (pp. 23–24), but we must remember that to the professional computor the slide rule is what a pocket-knife may be to the carpenter.

Perhaps the most notable chapters are those on the integration of differential equations by finite difference step-by-step procedures. These contain a wealth of novel formulae and procedures (many due to the author) designed to accelerate the convergence of the iterative feature of the calculations. Indeed such is the variety of alternative methods that one cannot help feeling that the time spent in a discriminating selection of which method to employ may often not be a negligible proportion of the total computing time. If we may ask for more when so much has been given one might have liked more help in how to deal with highly oscillatory problems, but the variety of ingenious schemes that the author has himself employed in solving problems of this kind may have led him to the conclusion that no general text-book rules can be given for this, beyond the Madelung transformation.

The average statistician may only occasionally meet the problems dealt with in this book, but it will be indispensable to all concerned with systematic scientific computations to average or high nominal accuracy.

H. O. HARTLEY.

10.—*The Role of Measurement in Economics.* By Richard Stone. Cambridge University Press, 1951. viii + 85 pp. 9″. 12*s*. 6*d*.

In this monograph Mr. Stone illustrates the main problems of statistical economics from the work being done at Cambridge on social accounting and demand analysis. It is a lively book which should be useful both to the economist wishing to learn of recent advances in these fields and as introductory reading for the student wishing to specialize in them. The theoretical sections are less interesting than the others, since they are sometimes difficult to understand, and contain

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

slips. This is particularly true of Section VI on "Postulates for a Theory of Choice", which contains at least one error of substance in addition to several formal ones.

Mr. Stone stresses the importance of structural models in the formation of economic policy. He constructs a simple dynamic savings-and-investment model and uses it to examine the effect of certain "common-sense" economic policies. In one case, for example, the government is assumed to become worried about the low level of savings. It cuts its own expenditure and budgets for a surplus. The result is unemployment and misery all round—as it is bound to be in an economy in which everything is determined by demand. In Mr. Stone's model, however, investment has no function, for there are no supply restrictions and there is unemployment. Why then would the government be worried about the lack of savings? It is the model rather than common-sense which is at fault.

The difficulty of estimating economic relationships is illustrated from demand analysis. There is a brief, but clear, discussion of the identification problem. On the other hand the reader is not warned of the disadvantages of the method of reduced forms, which will normally yield biased estimates even in the absence of serial correlation. The discussion of time series difficulties is fuller and very useful, but there is no mention of the danger that the precision of the regression coefficients may be considerably overestimated if the disturbances are autocorrelated, nor of the fact that least squares estimates of autoregressive parameters are biased. One important practical problem is ignored. In studies of aggregative demand one has to use indices of price and income. The correlation between two alternative price indices may not be much higher than that between one of them and an income series. In such cases the estimated price and income elasticities have little value. Similarly the disturbance will be largely made up of economic series, and, as such, may be highly correlated with some of the "explanatory" variables. This would lead to a bias in the regression estimates. It must be admitted, however, that the danger of this happening will be reduced by the "first difference transformation" recommended by Mr. Stone.

It is, perhaps, a pity that Mr. Stone has attempted to cram so many good things into such a short space. Though the inevitable result was that some important topics had to be skimped, this remains an excellent introductory text for the intending econometrician or social accountant.

W. M. GORMAN.

11.—*The Social Framework*. By J. R. Hicks. 2nd ed. Oxford: Clarendon Press, 1952. xiii + 283 pp. 7¼″. 12*s*. 6*d*.

It is ten years since the first edition of *The Social Framework* appeared. In those ten years there have been considerable developments in social accounting. In 1942 the work of Bowley, Stamp and Colin Clark was available and the first official exercises in national income compilation —"An Analysis of the Sources of War Finance . . . " and the first of the annual White Papers on the National Income had appeared. But few can have guessed how important a feature of the economic landscape the National Income White Paper was to become. Professor Hicks evidently had such perception and the national income took a central place in his *Introduction to Economics*.

Some of us who returned to academic life in the immediate post-war years were puzzled how to fit *The Social Framework* into our teaching. In Chapter XVIII of the new edition Professor Hicks has indicated his views of his book's place in the general body of economic teaching. It is to be regarded as a study in economic anatomy. Once the student has mastered it he may pass on to economic physiology—the way the economic system works. This is surely a very sensible programme. And a student who for whatever reason gets no further than the anatomy may well find himself more usefully equipped than one who has spent his time on elementary economic theory.

Much of *The Social Framework* is unchanged from the earlier edition. Facts are brought up to date; there are modifications of terminology designed to reduce some of the gap between social and orthodox accounting; and the section on the Social Product is rewritten to serve as a better introduction to the National Income White Papers in their modern form. Finally there are three new and more difficult supplementary chapters intended for those readers who return to social accounting after a study of other branches of economics.

The Social Framework has stood up well to the tests of ten years' service. The methods and terminology of the official National Income White Papers appear to be settling down, so the second edition may well have an assured life. But perhaps Professor Hicks was a little too quick in getting his copy to the printers. The latest National Income and Expenditure statement contains in Table 13 a summary of "Inter-industry transactions 1948" which may prove to be the beginning of a development as potent as the first official excursion into social accounting in the early 'forties. We should have welcomed Professor Hicks's gentle guidance into this new territory of input-output relationships.

P. A. DANIELL.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

12.—*Conference on Research in Business Finance* held under the auspices of the Universities—National Bureau Committee for Economic Research. New York: National Bureau of Economic Research, 1952. xii + 340 pp. 9″. $5.00.

This volume contains the papers and some of the ensuing discussions delivered to a conference held in June, 1951. The reviewer approached his task conscious of his ignorance of the subject yet hoping to learn much from the work. His hopes were largely disappointed.

In his foreword Simon Kuznets, Chairman of the Committee under whose auspices the Conference was held, draws the novice's attention to the possibility of using Irwin Friend's *Summary and Appraisal* for a preliminary canter round the vast and important arena of Business Finance. This idea is good in principle and might well be extended to other volumes of conference proceedings, but in practice Mr. Friend has interpreted his task as the rather lengthy enumeration of points of detail on which he disagrees with the various papers. The effective discharge of the important duty of summing up surely requires that the conference itself should have receded sufficiently into the past, say a month or two, for its general perspective to be perceived.

The earlier papers concern themselves in the main with obtaining information of a statistical character. Where do businesses get their funds from and how do they employ them? How does the size of a firm affect its sources and uses of funds? How are new firms financed? How should the projection of future capital requirements for industry be undertaken? All these questions are important and worthy of painstaking investigation. None of the contributors seems very successful in making them appear very exciting. A more or less standard pattern of attack is used throughout. The existing knowledge is enumerated, a few findings are described, and a plea is entered for the accumulation of almost limitless further information.

It is not easy to be satisfied that even the present knowledge has been fully exploited. There is a conspicuous lack of attention to theoretical considerations. Findings tend to be of the form that the debt-equity ratio is now x whereas before the war it was y. But there is virtually no attempt at interpretation in the fullest sense of the word. No one seems to have any simple hypothesis to test, and since the present array of statistics does not itself throw up an obvious hypothesis, the cry at once goes up that the assemblage of figures must be enlarged.

In general the participants in the discussion content themselves with merely adding to the already enormous list of further knowledge required. Occasionally, however, a shaft of light pierces the gloom; there is for example a short but interesting account by Alfred Oxenfeldt of the birth process of a new firm, on which the usual perfunctory collection of global statistics can hope to shed little light. Evsey Domar also manages to summarize the lengthy paper on projecting capital requirements in two short sentences:

> "1. A full employment level of output or capacity was projected forward at some rate of growth which was regarded as stable and easily obtainable from historical data."
> "2. Investment requirements were then computed as a function of the expected growth in output."

As he also points out, the assumption that the rate of growth of capacity is independent of the level of investment is a somewhat peculiar one.

The remaining papers do not eschew theory quite so religiously, and consequently reach a much higher level of interest. Neil H. Jacoby and J. Fred Weston explore and enumerate the various factors that may influence managerial decisions on the form in which finance is obtained. The most interesting part of their analysis deals with the present teaching imparted by American text-books on investment practice. Their list of possible factors influencing managements is so long and complicated that it quite rightly draws a protest from Mrs. Ruth P. Mack, who adds the sensible and pertinent comment that the "fundamental first step in the study of investment policy is the determination of the important questions to ask . . . Economists can only learn what to ask if they seriously try to understand how businessmen think about those problems whose solution ends in the purchase of investment goods."

David Durand's discussion of the costs of debt and equity funds for business opens with an attack on existing economic theory, but the other members of the conference were quick to point out that he had not understood what the theory really was. The gist of his argument appears to be that businesses attempt to maximize the present capitalized value of their future income, but that there are different methods of doing this, which may lead to different forms of financing.

By far the most complete analysis is that presented by Franco Modigliani and Morton Zeman, entitled, *The Effect of the Availability of Funds, and the Terms thereof, on Business Investment.* First a theory is developed, and then it is subjected to a statistical test. The corner-stone of their theory is that "management acts rationally to maximize the return to existing stockholders"—an assumption which is conceivably open to dispute. When, however, the return is uncertain the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

management attempts to maximise a utility function depending on the expected value of the return and the dispersion of its probability distribution. The problem is to discover under conditions of both subjective certainty and uncertainty how much new finance will be sought and how it will be divided between debt and equity.

Nothing new or startling emerges from the analysis of such a choice under certainty or when "risk aversion" is measured by the use of certainty equivalents. Under uncertainty with a more general utility function it is established that the amount of new finance is independent of the form of the utility function, which merely determines the proportion which is raised by the various means open to the management. There is clearly a considerable element of artificiality involved in separating out this type of managerial decision from all the other closely related decisions that must be taken. In the discussion Lawrence R. Klein points this out, and also expresses doubts about assuming that corporations accept as given and sacrosanct the market prices of their bonds and shares. As the problem has been set up, the management is given no scope for setting off one risk against another, but merely faces a "market opportunity function" which for a given amount of new capital shows that the expected rate of return to the existing stockholders is linearly related to the dispersion of the return.

The attempt at empirical verification is rather disappointing, but it is fair to add that the authors are at pains to assert that their investigations are only in the exploratory stage. They try to estimate the regression of a variable, the proportion of new funds raised by the issue of common stock, on other variables representing the relation of the long-term expected yield to the rate of interest and the accompanying uncertainty. Scant attention is paid either to the problem of identification or to the difficulties arising from serial correlation, which might be presumed to be considerable, since expected earnings are derived by averaging past earnings over a number of years and uncertainty by the standard deviation of past profits over the same period. In such circumstances ordinary tests of significance are of doubtful validity, although this fact is not admitted in the paper. Despite all their efforts, the authors cannot establish that their measure of uncertainty has any significant effect on their dependent variable.

The jump from theory to verification is so large that there is considerable doubt whether the statistical variables have any obvious correspondence with their theoretical counterparts. The need for establishing precisely what information businessmen take into account when making important decisions is clearly brought out. It may be rash to accept entrepreneurs' rationalizations of their own processes of thought, but there should be little objection in asking them when and how such processes are begun.

However inconclusive the results of Modigliani and Zeman's research are so far, here at least is a paper that is both stimulating and provocative, and which holds promise that something substantial will eventually emerge. They are clearly right to start with a simple theoretical framework which can be progressively improved as their research goes on.

The last thought that occurs as this book is put down is whether a thoughtful and analytical businessman explaining what he thinks he is doing when he raises funds in a particular way would not shed much more light than a herd of academic minds, however brilliant, pondering over a mass of figures. But perhaps this is what many of the contributors to the discussion thought when they pleaded for case studies of individual firms.

A. D. Roy.

13.—*The Pattern of United States Import Trade since* 1923: *Some New Index Series and their Application.* By John H. Adler, Eugene R. Schlesinger and Evelyn van Westerborg. New York: Federal Reserve Bank, 1952. 136 pp. 10″.

A large part of this book consists of tables giving index numbers of quantities and unit values of United States imports from 1923 to 1950, classified by broad economic classes and by region (with a certain number of countries also given separately). For the remainder of the book the authors try to use the index numbers which they have calculated to obtain "Rules" of American import demand.

The large collection of index numbers should prove of great assistance to others wishing to work on United States import statistics. The labour involved in computing such index numbers has caused most workers to rely on total figures, with the result that it has been only too easy to criticize their conclusions.

The method used by the authors is to take, for each of their economic classes, a sample of commodities for which the "unit value", inevitable in work with trade returns, is likely to be a reasonable indication of true price movements. A price index is worked out for the sample using the Fisher "ideal" formula with 1935–39 as base. Quantity indices are found by deflating the total value of imports in the class by this price index. Index numbers for all imports from the different regions are estimated by combining these deflated series.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The index numbers for all imports which result from the process described would seem to differ from the "ideal" indices even if the coverage of each class were complete. The difference is likely to be small, but the fact that index numbers of hybrid formulae are produced strengthens doubts whether the use of the "ideal" formula is worth while.

The assumption implicit in the calculations is that the prices of all goods in an economic class move in the same way as the goods in the sample, whereas the same would not be true of quantities. The authors take pains to stress that this seems to them a reasonable assumption. Doubtless in most cases it is, but there are a few points which may cause some misgivings. One is the difficulty which was found in many cases in calculating index numbers for prices including duties, since "the average duty rates of the sample commodities did not appear to be the same as those applicable to the entire economic class". If the sample is not representative from this point of view, is it necessarily so for prices? The classes are broad, and may cover commodities with widely differing price movements. Further, is it reasonable to assume that prices before duty form a more representative sample than prices including duties when we are dealing with a country of the economic importance of the United States? A second point arises from the violent fluctuations over time which occur in some cases in the percentage of imports in the class which fall within the sample. May not part of the reason for such fluctuations be differing price movements of commodities in the sample and of others in the class? In view of the importance which the authors attach elsewhere to the effect of price on imports, it is difficult to dismiss this possibility. As an unimportant illustration we can take the imports of crude foodstuffs from the United Kingdom. The sample covered 89 per cent. of the value of the class in 1937, but only 6 per cent. in 1948, which may cause misgiving. The price index as given by the sample is 414·9 in 1947, 331·0 in 1948, and 165·0 in 1950. One must feel doubtful, in view of this surprising movement, whether the indices, apparently based on three commodities, have any clear or useful meaning.

It is, of course necessary to make some such assumptions as those made by the authors if one is to make any estimates. When dealing with a group for which the sample provides a large and stable proportion of total imports, the method is likely to give reasonable results. Many of the other indices should, perhaps, be treated with far more caution than would be suggested on reading the description.

The attempt to find "rules" of American import demand, which is the main purpose of the work, is made partly by the presentation of tables and charts and partly by regression analysis. The charts are designed to bring out the effects of income and prices, and of such "non-systematic" changes as the effects of the war and of the repeal of prohibition. The interesting discussion of these points suffers slightly from a varying basis of comparison—sometimes individual years are compared, sometimes averages of several years, and no reason is given.

The authors are aware of the criticisms which have been made of the use of regression analysis on data such as theirs, but reach the comforting conclusion that many of the criticisms do not apply to their work. The reasons given in support of this conclusion seem, however, rather unsatisfactory. It is difficult to see why the suggestion, even if true, that the supply of finished manufactures for the American market is almost perfectly elastic should, in itself, get rid of bias due to shifts in the demand surface and leave us with "true demand elasticities". It is interesting to note that the type of commodities considered most suitable for estimating demand elasticities are just the reverse of those considered suitable by the early estimators of demand elasticities.

The argument that there is likely to be bias in the estimates due to the use of index numbers is largely dismissed by the assumption that the prices of commodities in one class from one area are likely to move approximately in the same way. As has been stated earlier, the authors seem overconfident in this assumption.

It is to be regretted that the term "high degree of multicollinearity" is used as almost synonymous with a high coefficient of correlation between the two explanatory variables. The phrase "since a high degree of multicollinearity exists between the two explanatory variables" is one example of the results of this loose terminology.

The final question which must be raised is how far the results of the calculations for 1923–37 can be usefully applied to the post-war situation. The authors appear to treat the problem rather lightheartedly. For example, after saying that the calculations may not always give demand elasticities but provide information about the historical course of events, the result of the interaction of the forces of supply and demand, they suggest that the same reactions may well hold in the future. The assumption of an unchanged "structure" for American import trade implied seems unduly optimistic when viewed in the light of changes which have taken place since 1937.

It is also difficult to understand why the similarity of the average elasticities derived from linear equations in the variables and the elasticities derived from linear equations in their logarithms should suggest that the elasticities can be used outside the range of the data. This means that the logarithmic form of equation is accepted since, for the non-logarithmic form, the elasticities vary

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

considerably even within the range of the data. Further, when the relationship of the *absolute* level of imports to the level of the gross national product has admittedly changed in post-war years, there seems little reason to assume that the elasticity (rather than, say, the slope) of the demand curve is the feature to remain unchanged—unless the obsession of economists with elasticities has a more solid foundation than is usually supposed.

In order to remove the impression which might be left by the criticisms given, it should be said that the authors have provided a stimulating and painstaking analysis of American import demand. They have presented a vast amount of data for further study, and they have tackled a subject with a literature already large and controversial with great courage and skill. Their attempts to carry out the analysis on a regional rather than a global basis are of particular value. Unlike most other investigators, their results suggest a high response of imports to price. They may be right.

W. J. CORLETT.

14.—*Approaches to Problems of High Fertility in Agrarian Societies.* Papers presented at the 1951 Annual Conference of the Milbank Memorial Fund. New York, 1952. 171 pp. 9″. $1.

The amount of food and other resources available place an upper limit upon the size of the population that can be supported. From time to time in human history, no doubt, the numbers of men and women have reached this limit, and the process of adaptation to it must have borne harshly upon them. Since the War of 1939–45 there has been much discussion of the need to mitigate this harshness, and the manner in which the subject has been approached is illustrated by the topics chosen for consideration at the Annual Conferences of the Milbank Memorial Fund. In 1947 members of the staff of the United Nations Organization referred to plans for giving help to the "underdeveloped" areas of the world; in 1949 emphasis was placed on the probable demographic consequences of giving such help; two years later the question is raised of attempting to reduce fertility in agrarian societies.

Although variously presented, the thread of the argument appears to run generally as follows: One of the first effects of giving aid will be a reduction in mortality, for the new drugs and treatments for preserving life are readily available, easy to administer and generally acceptable to the local population. To raise agricultural and industrial production is a harder task; the necessary equipment is more costly, and the abandonment of traditional methods of farming involves a social revolution. Consequently population may grow faster than resources, and there is a danger that the aid given will bring about no improvement, or even a worsening, in the wealth per head of the population, with possibly disastrous results. In these circumstances attention is devoted to the prospects of a reduction in fertility; as this cannot be expected to fall of its own accord fast enough to slow up population growth materially, the question arises whether steps can be taken to encourage birth control.

At this point great difficulties of various kinds arise. In the first place, any interference with natural reproductive processes is considered by many creeds to be immoral. Again, if a fall in fertility is brought about, there is considerable uncertainty as to the lengths to which it may go and the consequent social effects. Little appears in the book on these matters, for attention is concentrated on other problems such as the persistence of tradition in regard to marriage and family in agrarian societies, the lack of data and the best method of approaching a new and difficult subject.

There are eleven papers by different authors; one is introductory, and the remainder are classified into three groups dealing respectively with the social customs associated with marriage and childbearing in certain areas, with the means of fertility control and with plans for future research and action. Inevitably there is overlapping, and the order in which the papers are presented is not altogether the best one in which to read them. In particular, the contribution of Warren S. Thompson on "Types of knowledge needed for an adequate approach to problems of (high) fertility in agrarian societies" presents matters so well as to deserve the early attention of the reader.

Whether or not it is true, as Notestein has asserted, that every population restricts its fertility in some degree, it seems clear from the articles about Japan, India, Mexico and Puerto Rico that such restrictions as are at present practised are insufficient to prevent a growth in numbers. The attitude of the natives in these countries varies considerably. India seems unprepared, socially or politically, for birth control except perhaps by means of postponing marriage—which, as Thompson points out, might be quite ineffective in reducing the average family size. The Japanese are accustomed to limiting fertility, but the methods used and the extent of their employment are insufficient to prevent rapid increases in the population. Sample surveys undertaken in Mexico and in Puerto Rico are described in two interesting papers which reveal some awareness of the problem among the people, but not enough to influence practical performance much, perhaps because contraceptives are at present too expensive and complicated for widespread use. If fertility is to be reduced, there

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

is a need for a simpler and cheaper agent. Clair E. Folsome describes the progress of scientific research on this subject, and suggests that what is required is the discovery of some antimetabolic compound for oral administration, capable of halting the maturation of sperm and ova; the rate of advance in medical matters has been so rapid recently that it would be rash to deny the possibility that such a compound will soon be found.

The impact upon the world of a discovery of this kind would be comparable with that of other recent developments, for instance in nuclear fission. Overemployment of the new instrument would certainly be dangerous, and might well place future world power in the hands of nations banning its use. It would have been well if one article at least in the book had been devoted to warnings of the dangers ahead in this direction.

P. R. Cox.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

(1) British Official Statistics

The interim index of retail prices published by the Ministry of Labour and National Service which stood at 138 (prices at June 17th, 1947 = 100) at July, 1952, fell to 137 in August and 136 in September. It then rose again to 138 for the remainder of 1952. The temporary reduction was mainly due to a fall in the prices of potatoes and fruit. The subsequent rise was due to increases in the prices of bacon, butter, margarine, cooking fat, cheese and sugar resulting from the reduction in the subsidies. Separate figures on the same basis for different groups of commodities are not available, but the following are the figures based on January 15th, 1952 = 100:

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Alcoholic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
July 15th	108·5	102·6	97·0	100·9	98·2	103·7	103·1	101·2	100·0	103·8
Aug. 12th	106·8	102·8	96·4	101·1	98·0	103·1	105·2	101·2	100·0	103·2
Sept. 16th	106·1	102·9	95·9	101·7	97·7	103·1	106·2	101·2	100·0	103·0
Oct. 14th	108·3	103·3	95·5	101·8	97·1	103·1	106·4	101·1	100·0	103·9
Nov. 18th	107·9	103·4	95·6	103·3	97·1	102·7	106·7	101·1	100·0	103·8
Dec. 16th	109·3	103·6	95·3	104·5	97·2	102·7	107·0	101·1	100·0	104·5

The Ministry of Labour index of weekly wage rates which was 129 (June 30th, 1947 = 100) at the end of July, 1952, rose to 130 in August, 131 in September and October, and 134 in November and December. The increases in wage rates during this period affected mainly engineering and shipbuilding, railways, iron and steel manufacture, retail distribution, gas and electricity supply, and agriculture.

The six-monthly inquiry into average earnings, the results of which became available in September, showed that in April, 1952, the average weekly earnings in the industries covered by the Ministry of Labour returns were 173*s.* 7*d.* for men, 92*s.* 2*d.* for women, 71*s.* 9*d.* for boys and youths, and 57*s.* 9*d.* for girls. These figures represent increases over October, 1938, of 152, 184, 175 and 212 per cent. For all workers combined the average was 147*s.* 3*d.*, 177 per cent. more than in October, 1938. The index number for April, 1952, compared with 100 at April, 1947, was 142. The average weekly hours worked fell slightly from 46·1 in October, 1951, to 45·6 in April, 1952. In manufacturing industries alone the average weekly earnings of men in April, 1952, were 179*s.* 4*d.* and those of women, 92*s.* 6*d.*

The total working population and the numbers in civil employment in the six months ended November were as follows:

(*Thousands*)

	Total Working Population			*Number in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
June, 1952	15,978	7,338	23,316	14,950	7,191	22,141
July, ,,	15,979	7,340	23,319	14,940	7,189	22,129
Aug., ,,	16,017	7,385	23,402	14,968	7,228	22,196
Sept., ,,	16,018	7,373	23,391	14,962	7,213	22,175
Oct., ,,	16,020	7,374	23,394	14,941	7,208	22,149
Nov., ,,	16,010	7,394	23,404	14,921	7,234	22,155

The number of persons on the unemployment registers of the Employment Exchanges rose by 10,110 in August. It then fell in September and October and rose again towards the end of the year. The total of 399,461 at December 8th, 1952, represented 1·9 per cent. of the estimated total of employees in Great Britain. The percentages in the separate Regions ranged from 0·8 in the North Midlands to 3·5 in Scotland, and 3·0 in Wales.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The following is a sex analysis of the figures:

Numbers of Unemployed Persons on the Registers of Employment Exchanges

Date	*Men and Boys*	*Women and Girls*	*Total*
July 14th, 1952	209,938	183,526	393,464
Aug. 11th, ,,	221,282	182,292	403,574
Sept. 15th, ,,	214,250	175,370	389,620
Oct. 13th, ,,	228,225	169,668	397,893
Nov. 10th, ,,	239,987	166,379	406,366
Dec. 8th, ,,	248,706	150,755	399,461

Of the total of 399,461 at December 8th, 31,869 were temporarily stopped, 92,748 had been unemployed for not more than 2 weeks, 116,374 for 2 to 8 weeks, and 158,470 for more than 8.

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employed, were as follows:

July, 1952	754,500	Oct., 1952	882,200
Aug., ,,	764,500	Nov. ,,	865,700
Sept., ,,	802,700	Dec., ,,	936,900

The numbers of employed persons absent owing to industrial injury in the same six months were 53,200, 53,100, 58,500, 62,200, 62,300 and 59,300.

Figures published in the *Ministry of Labour Gazette* for November show that the number of members of trade unions at the end of 1951 was 9,480,000, the highest figure yet recorded. It showed an increase of 238,000 on 1950. Of this total 6,305,000 were in 17 unions each with a membership of 100,000 or more. At the other end of the scale, 611 of the 704 unions accounted for less than 9 per cent. of the total membership.

The first detailed costing returns for hospitals in the National Health Service in England and Wales have been published by the Ministry of Health (*National Health Service: Hospital Costing Returns, year ended 31st March*, 1951. H.M.S.O. 10*s.*) They cover some 2,750 Hospitals.

The widely varying systems of accountancy in operation before the Health Service began in 1948 made it impossible to introduce a uniform system of hospital cost accounting at the outset. Early in 1950 the then Minister of Health, on the advice of the Central Health Services Council, invited the King Edward's Hospital Fund for London and the Nuffield Provincial Hospitals Trust to undertake a complete unit costing of a small number of representative London and provincial hospitals. The two organizations agreed to co-operate in the investigation, and the ultimate form of costing most suitable to the hospital service will be considered in the light of their report when received.

As an interim measure a relatively simple system of cost analysis, based on the headings of the financial accounts, has been introduced and forms the basis of the present returns. This system was recommended in a report by a committee appointed by the Treasurers of Regional Hospital Boards, and adopted by the Minister after consultation with the financial officers of Boards of Governors. It was felt that such a scheme could be operated satisfactorily throughout the hospital service and, as a beginning, would provide a reasonable measure of cost accounting.

Every hospital is classified in the return according to its primary function, for example, wholly general, mainly chronic, maternity, mental, etc., and the hospitals are listed in descending order of size. After showing the gross expenditure over some twenty subjective headings three main sets of figures are worked out. These are: (1) the total inclusive net cost per week of maintaining a patient; (2) the same cost after allowing for out-patient expenditure. This is done by assuming that in the absence of a statement of the actual cost five out-patients' attendances equal for costing purposes one in-patient day (the Ministry admit that this may be questionable, but argue that no better standard has yet been proposed); and (3) the same cost further adjusted to allow for "vacant

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

bed factor" (beds staffed but not occupied), i.e., to indicate what the cost would be if the hospital were full. It is a large adjustment in some under-occupied small hospitals.

Costs Compared

For the purpose of comparing the cost per patient between hospitals of the same type or between one type and another, the Ministry consider that the *inclusive net cost after allowing for out-patient expenditure* (where applicable) provides a reasonable basis of comparison. In the following table this figure is used to compare the average cost per patient in various types of *non-teaching hospitals* in the 14 hospital regions of England and Wales together with national averages.

Average Cost per week of Maintaining a Patient in the Year ended March 31st, 1951

Region	*Wholly General*	*Mainly Chronic*	*Maternity*	*Mental*	*Tuberculosis*
	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
Newcastle upon Tyne	12 6 6	6 17 1	15 9 8	3 11 11	6 14 7
Leeds	13 4 7	7 13 1	16 19 0	3 9 10	9 0 9
Sheffield	12 11 1	5 18 8	15 4 1	3 18 1	7 10 6
East Anglian	13 14 11	6 17 1	15 4 4	3 10 6	9 15 0
North West Metropolitan	17 0 8	11 3 1	17 14 7	4 5 2	12 10 11
North East Metropolitan	14 7 11	7 13 11	19 0 7	4 2 3	9 16 1
South East Metropolitan	14 14 11	11 17 2	17 10 6	3 13 1	10 7 4
South West Metropolitan	14 1 4	7 16 0	15 15 4	4 2 10	8 18 11
Oxford	16 1 7	6 10 0	17 14 0	3 17 0	10 14 4
South Western	15 1 2	4 11 9	15 11 9	3 15 7	9 7 7
Welsh	11 18 6	7 12 10	16 5 3	4 0 6	8 2 8
Birmingham	13 0 0	9 0 0	18 4 7	3 9 6	8 2 6
Manchester	11 19 0	5 7 3	14 5 2	3 7 6	7 8 0
Liverpool	11 10 3	*Nil*	14 1 4	3 7 10	8 9 1
National averages	13 10 3	6 18 4	16 9 5	3 15 11	8 17 2

Teaching Hospitals

For teaching hospitals classified as wholly general the average weekly cost per in-patient, computed on the same basis, was £23 16*s.* 10*d.* in London and £17 5*s.* 10*d.* in the provinces.

Source of Differences

Many detailed comparisons can be made of costs of different services in different types of hospital. To select one example we may compare the "wholly general" group weekly cost per patient in the North West Metropolitan Region (£17 0*s.* 8*d.*) with that in South-West Metropolitan Region (£14 1*s.* 4*d.*). The following differences are revealed:

	N.W. Metropolitan	*S.W. Metropolitan*	*Difference*
	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
Provisions	2 4 5	1 16 10	7 7
Drugs, dressings and medical appliances	2 2 4	1 14 3	8 1
Laundry	11 9	7 3	4 6
Salaries—			
Medical	3 13 5	2 18 4	15 1
Nursing	4 12 4	4 5 3	7 1
Other Staff	6 11 3	5 2 1	1 9 2
Fuel Light	1 5 8	18 2	7 6
Adjustment for Out-patient service	5 8 0	3 11 2	1 17 10

In the main these differences can be seen from the detailed tables to arise from the following factors:

(1) The S.W. Metropolitan Region stretches as far west as West Dorset and has many more hospitals outside the high-priced Metropolitan area. Many more of its staff are outside the area of applying London weighting to salaries (to compensate for the higher prices in the Metropolitan area).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(2) The S.W. Metropolitan Region has a large number of cottage hospitals (and the N.W. Metropolitan Region very few) where medical appliances, etc., cost little because expensive services necessarily cannot exist.
(3) The N.W. Metropolitan Region has to maintain relatively more out-patient services for the cost of which it may not be fully compensated by the arbitrary adjustment made.

More Information Required

The broad picture is thus reasonable but individual anomalies may be puzzling. A 300-bed county town hospital in one Region spends £2 5*s.* 11*d.* per week per patient on provisions, while a hospital of only slightly larger size in the centre of London spends £2 3*s.* 11*d.*—less rather than more as one would have expected. What is not revealed by the cost per *bed* is the fact that the former hospital feeds a relatively much larger number of resident and non-resident staff, i.e., the cost per *person fed* is not excessive but reasonable and comparable. Two London (wholly general) hospitals of equal size spend £2 1*s.* 11*d.* and £1 18*s.* 0*d.* respectively on provisions. Within the London Teaching Groups the apparent anomalies are more emphasized—one hospital spends £3 17*s.* 7*d.* on provisions and another of comparable size £2 17*s.* 9*d.* Again the number of persons fed is more important than beds. There are large variations in staff costs in the tables which are difficult to understand. The very object of the analysis is to force administrators to probe these puzzling differences; either to deny them (for figures sometimes mislead, and certainly the costing figures are too rudimentary to provide a basis for absolute comparison); or to remove them in the interests of public economy; or to justify them on the grounds of *medical* efficiency, i.e., that a higher cost may sometimes mean a more efficacious treatment.

The Census of 1951 was the first from which a small sample of the total records collected at the enumeration was isolated so that it could be quickly analysed and its results issued well in advance of any tabulation of the full census returns. The sample covered 1 per cent. of the 1951 population of Great Britain and provided the material for the tables in this two-part publication (*Census* 1951, *Great Britain. One per cent. Sample Tables.* London, H.M.S.O., 1952. Part I, 17*s.* 6*d.*; Part II, £2). Part I deals with ages and marital conditions, occupations, industries and the housing of private households; Part II with the characteristics and composition of private households, and also with non-private households, education, birth-place and nationality, fertility, and the use of Welsh and Gaelic languages. The analysis follows the usual geographical divisions and, in addition, gives, in a supplement to Part II, tables for seven conurbations enclosing continuously urbanized areas surrounding large population centres.

As information about ages is specially subject both to irregularities arising from mis-statements in the original records and to errors due to sampling deviations, a special set of graduated age-tables, by sex, is added in Part II, Appendix B, accompanied by a detailed account of the method of graduation and the reasons for its adoption.

The methods of selecting and processing the sample records are described in the Introduction (which is reproduced in Part II for the benefit of those using only that Part). Here also are particulars of the scope and design of the tabulations, the methods by which necessary adjustments to the sample were made, and the considerations which must be borne in mind when interpreting sample results. Such considerations include the different degrees of error attaching to sample items of different sizes.

The general explanatory notes, maps, specimen schedule, etc., provided should materially help users to handle the results effectively.

(2) OTHER STATISTICS

After many years of preparation the United Nations Educational, Scientific and Cultural Organisation has now completed a first edition of the educational organisation and statistics of 57 countries (*World Handbook of Educational Organisation and Statistics.* Paris, 1951. 51*s.* 6*d.*) After a valuable introduction on the history of this project and on the differences in the systems and the statistics in different countries, monographs, prepared in most cases with the collaboration of governments or Unesco's national committees, give an outline of the educational structure of each country, a diagram of the organisation of the school system, and tables of the number of educational institutions, of teachers, of scholars (by sex and age-groups for recent years), of diplomas and of expenditure on education. Information is given by types of school for a pre-war and a post-war year, and a glossary of the terms used in different countries to describe these

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

different types is added. Apart from some summary tables in the U.N. Statistical Yearbooks, and a volume compiled by the Institute of Education nearly 10 years ago, no comprehensive survey of educational statistics has hitherto been available, and this volume, which, it is emphasised, is a first edition, fills a gap; future editions will no doubt be considerably expanded.

The second edition of the *United Nations Yearbook of International Trade Statistics* (for 1951) has recently appeared (New York, 1952, 272 pp., $2.50). The scope of the tables is the same as that of the first edition (see this Journal, 1952, Part I, p. 155), but the number of countries covered is now 52 instead of 42. A new feature is the classification of imports and exports according to the United Nations Standard International Trade classification. Twenty countries have re-classified their statistics for 1950 or 1951 in this way. Summary tables for each country cover the years 1930 to 1951, and detailed tables, the years 1938 and 1948 to 1951.

CURRENT NOTE

Fellows of the Society will be glad to know that our recent President, Professor Bradford Hill, has been elected an Honorary Fellow of the American Public Health Association in recognition of his outstanding services in the field of public health. A measure of this distinction is indicated by the fact that there are only 29 Honorary Fellows of the Association.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

OBITUARY

Augustus D. Webb

1880–1953

Mr. A. D. Webb, C.B.E., B.Sc.(Econ.), M.A., who died on January 27th this year, became a Fellow of the Royal Statistical Society in 1908, and served on the Council for 14 years between 1921 and 1941. Educated at a public elementary school he entered the Civil Service as a boy-copyist at the age of 14, and after some years of private tuition rose to become a Second Division Clerk in the Board of Customs. At his retirement in 1944 he was an Assistant Secretary and head of the Intelligence Division of Customs and Excise, with special duties in the preparation of the Budget.

Continuing his early education he became an evening student at the London School of Economics soon after the establishment of the Faculty of Economics (1900), and was the earliest to obtain a First Class Degree with Statistics as special subject in 1907. This involved considerable knowledge of mathematical statistics, but his interest was mainly in exactitude of definition and comparability, as was shown in his two communications to the Society in 1909 and 1913. About 1909 he accepted an invitation to compile "*The New Dictionary of Statistics, A Complement to the Fourth Edition of Mulhall's Dictionary of Statistics*", 1911. This was an enormous and exhausting task. *Mulhall's Dictionary* was well known from the '80's of last century. It had its utility, but (as Professor Alfred Marshall warned me) it was marred by the inclusion of extravagant guesses with ascertained facts. Mr. Webb in 682 quarto pages examined the original sources (largely foreign) of the tables included by Mulhall, brought them up to date and in all cases gave careful definitions of their content. In the words of his preface, "No explanatory matter, either in the way of footnotes or of text, that may accompany figures should be left unread or ignored. Especially is this necessary when comparisons are in question . . . between one period and another, and still more . . . between one country and another". The publishers, George Routledge & Sons,* inform me that "It was a publication very well received and had a good sale. All the copies have been sold". It is a matter of regret that Mr. Webb's special talent was only used directly within the Government Service, for his only other known work was the editorship of the *Statesman's Year Book* for several years.

A more intimate appreciation of Mr. Webb is to be found in a letter in *The Times* of February 3rd, from which some of the data used above have been drawn.

Mr. Webb in his will generously bequeathed to the Society a number of books from his Library.

A. L. Bowley.

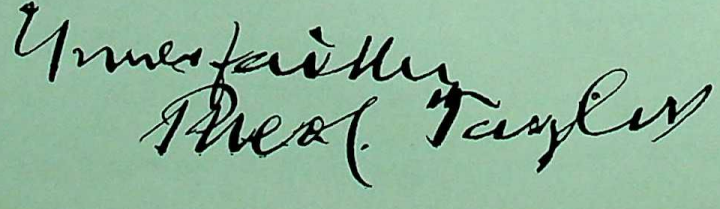
* Now Routledge and Kegan-Paul.

Mr. Theodore Taylor

1850–1952

With the death on October 19th, 1952, of Mr. Theodore Taylor at the age of 102, the Society lost its oldest Fellow, both in terms of age and of Fellowship, his election to Fellowship having taken place in 1888. In 1891 he became the head of the family business of J. T. & T. Taylor, woollen manufacturers in Yorkshire, after some 25 years' service with the firm, and was active as Chairman of the concern until his death. He was throughout his life an ardent exponent of the principle of profit-sharing in business, and as long as 60 years ago introduced it into his own firm with conspicuous success. Mr. Taylor took advantage of every opportunity to expound his views on the subject, which he expressed with courage and vigour. Even at the advanced age of 99 he fulfilled public engagements to advance the cause. From 1900 until 1918 he represented a Lancashire constituency in Parliament as a Liberal, and during this period was largely responsible for the public condemnation of the opium traffic between India and China.

On the occasion of his 100th birthday the senior Honorary Secretary conveyed to him the felicitous greetings of the Society. It was typical that Mr. Taylor should reply in his own handwriting, and Fellows will be interested to see the photograph below of his signature taken from that reply.



CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

July 1952—Some business applications of marginal analysis—with particular reference to inventory control: *T. M. Whitin.* A short history of tallies: *R. Robert.* An alternative presentation of social accounts: *E. Fuerst.* A theory of cost and cost accounting—II: *G. D. de Swardt.* The effects of the Local Government Act, 1948, and other recent legislation on the finances of local authorities: *A Research Working Party.*

Biometrika—

December 1952—Estimation by double sampling: *D. R. Cox.* The statistical significance of odd bits of information : *M. S. Bartlett.* Sampling from bivariate non-normal universes by means of compound normal distributions: *H. Hyrenius.* The estimation of the Poisson parameter from a truncated distribution: *P. G. Moore.* The fitting of grouped truncated and group censored normal distributions: *P. M. Grundy.* Estimation of the mean and standard deviation of a normal population from a censored sample: *A. K. Gupta.* Use of scores for the analysis of association in contingency tables: *E. J. Williams.* Properties of distributions resulting from certain simple transformations of the normal distribution: *J. Draper.* On a two-sided sequential *t*-test: *S. Rushton.* Tests of fit in time series: *P. Whittle.* Tensor notation and the sampling cumulants of *k*-statistics: *E. L. Kaplan.* Rank analysis of incomplete block designs. I. The method of paired comparisons: *R. A. Bradley* and *M. E. Terry.* Studies in statistical ecology: *J. G. Skellam.* The estimation of population parameters from data obtained by means of the capture-recapture method. II. The estimation of total numbers: *P. H. Leslie.* The growth, survival, wandering and variation of the long-tailed fieldmouse, *Apodemus sylvaticus.* III. Wandering power and distribution: *H. P. Hacker* and *H. S. Pearson.* Samples with the same number in each stratum: *W. L. Stevens.* Approximations to the probability integral of the distribution of range: *N. L. Johnson.* Statistical control of counting experiments: *H. O. Lancaster.* Uppers and 1% points of the maximum *F*-ratio: *H. A. David.* The conditions under which Gram-Charlier and Edgeworth curves are positive definite and unimodal: *D. E. Barton* and *K. E. Dennis.* Comparison of analysis of variance power functions in the parametric and random models: *N. L. Johnson.* On exact grouping corrections to moments and cumulants: *M. Kupperman.*

British Journal of Psychology—

November 1952—The estimation of a point biserial coefficient of correlation from a phi coefficient: *W. B. Michael, N. C. Perry* and *J. P. Guilford.* The hierarchical organization of cognitive levels: *E. M. Moursy.* An iterative method for computing inverse matrices: *M. Hamilton.* An investigation into the prognostic value of certain arithmetic tests at the age of eleven plus: *J. Sutherland.*

British Journal of Social Medicine—

July 1952—Some epidemiological aspects of acute rheumatism: *D. Hewett* and *A. Stewart.* Observations on all births (23,970) in Birmingham, 1947. VII: *J. R. Gibson* and *T. McKeown.* Birth weights of South African babies: *E. J. Salber* and *E. S. Bradshaw.* Relative frequencies and sex distributions of human multiple births: *R. G. Record.* Incidence of common infections of childhood: *B. Benjamin* and *A. T. Gore.*

October 1952—Statistical theory of prophylactic and therapeutic trials. II. Methods of operational advantage: *L. Hogben* and *R. Wrighton.* Cohort analysis of fertility in England and Wales, 1939–50: *Wallis Taylor.* Stature of Scotsmen aged 18 to 40 years in 1941: *E. M. B. Clements* and *K. G. Pickett.* Incidence of neurosis related to maternal age and birth order: *A. Norton.* Factors influencing sex differences in mortality from respiratory tuberculosis in England and Wales: *J. C. McDonald.* A note on the sex ratio in anencephalus: *B. Mcmahon* and *T. McKeown.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Economica—

August 1952—Planning by economic survey: *E. Devons.* A rehabilitation of the classical theory of marginal utility: *H. Bernardelli.* The acceleration principle and the theory of investment: a survey: *A. D. Knox.* The pricing of manufactured products: *R. S. Edwards.*
November 1952—The classical monetary theory: the outcome of the discussion: *G. S. Becker* and *W. J. Baumol.* A note on railway constructional costs 1825–1850: *H. Pollins.* Price changes and the stability of the balance of trade: *W. Beckerman.*

Economic Journal—

September 1952—British and American exports: a study suggested by the theory of comparative costs. Part II: *G. D. A. Macdougall.* The origins of resale price maintenance: a study of three branches of retail trade : *B. S. Yamey.* A graphical analysis of the foreign trade multiplier: *R. Robinson.* Systems of aggregative index numbers and their compatibility: *R. Stone* and *S. J. Prais.* Productivity in an expanding economy: *A. Maddison.* Incentives in the building industry: *V. L. Allen.*

Faculty of Actuaries, Transactions—

Vol. XX, Part III—Mortality of life office annuitants.

Heredity—

April 1952—Statistical methods in genetics: *R. A. Fisher.* Blood groups, anthropology and language in Wales and the Western counties: *A. E. Mourant* and *I. M. Watkin.*

Incorporated Statistician—

October 1952—The teaching of statistics: *J. Wishart.* The statistician in business: *E. L. Lloyd.* Some thoughts on index numbers: *A. J. H. Morrell.* Organization of a statistical department: *T. Cauter.*

Manchester Statistical Society, Transactions—

Session 1951–52—Censuses of production: *J. Stafford.* Cost of distribution in department stores: *L. Cohen.* Management and accountability in the nationalised industries: *D. N. Chester.* Organisation for European economic cooperation: *A. K. Cairncross.* Road casualties—some facts and trends: *B. K. Young.*

Oxford University Institute of Statistics, Bulletin—

August 1952—Monetary policy again: a symposium: *R. V. Roosa, R. Frost, J. R. Hicks, E. V. Morgan, R. F. Kahn, Joan Robinson, E. Nevin* and *H. G. Johnson.*
September and October 1952—Earnings and living standards in Moscow: *T. Schulz* and *P. Wiles.* Dockworkers' earnings: *K. G. J. C. Knowles* and *A. Romanis.*
November and December 1952—National survey of personal incomes and savings: *H. F. Lydall.* The paradoxes of 1952: *D. G. Holland* and *D. Seers.* A 'human needs' diet in November, 1952: *T. Schulz.*

Population Studies—

November 1952—Theory of population and modern economic analysis. I: *A. T. Peacock.* Differential fertility in Ontario. An application of factorial design to a demographic problem: *N. Keyfitz.* Territorial differentials in fertility in the Union of South Africa—1911–1936: *L. T. Badenhorst.* Attitudes to the census and vital registration in East Africa: *J. E. Goldthorpe.*

Review of Economic Studies—

Vol. XX(1), No. 51—Demand, supply and the price level in macro-economics: *H. Rose.* Estimating departmental intervention: *E. Nevin.* The production function in Leontief models: *B. Cameron.*

Society of Actuaries, Transactions—

July 1952—Special investigation of group hospital expense insurance experience: *S. W. Gingery.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

UNION OF SOUTH AFRICA—

South African Journal of Economics—

September 1952—The politico-economic background of Jan van Riebeek's settlement: *H. M. Robertson.* The finance of international economic co-operation in peace and war: *I. S. Lloyd.* J. M. Keynes. Part II—his theory (reviewed article): *H. R. Burrows.*

UNITED STATES—

American Academy of Political and Social Science, Annals—

September 1952—Meaning of the 1952 Presidential election. (Whole number.)
November 1952—Murder and the penalty of death. (Whole number.)

American Economic Review—

September 1952—Comments on stochastic macro-economic models: *G. H. Fisher.* Production functions and the theory of international trade: *S. Laursen.* A note on multi-country trade: *G. S. Becker.*

American Statistical Association, Journal—

September 1952—The world series competition: *F. Mosteller.* An analysis of variance for paired comparisons: *H. Scheffé.* Some nonparametric tests for Student's hypothesis in experimental designs: *J. E. Walsh.* The power of two difference-sign tests: *A. Stuart.* Numerical tabulation of the distribution of Kolmogorov's statistic for finite sample size: *Z. W. Birnbaum.* The multiple-partial correlation coefficient: *D. J. Cowden.* Estimation in the truncated normal distribution: *M. Halperin.* Multistation inspection schemes: *G. J. Lieberman.* Some considerations in the use of the residual method of estimating net migration: *J. S. Siegel* and *C. H. Hamilton.* Survival curve for cancer patients following treatment: *J. Berkson* and *R. P. Gage.* An aptitude test for predicting success in a first course in statistics: *D. F. Votaw, Sr.* Population projections for sales forecasting: *M. J. Hagood* and *J. S. Siegel.* Hicks' "elementary case" economic model for the United States, 1929–1941: *G. H. Fisher.*

Annals of Mathematical Statistics—

September 1952—The χ^2 test of goodness of fit: *W. G. Cochran.* Some rank order tests which are most powerful against specific parametric alternatives: *M. E. Terry.* Combinatorial properties of group divisible incomplete block designs: *R. C. Bose* and *W. S. Connor.* The operating characteristic of the control chart for sample means: *E. P. King.* The use of previous experience in reaching statistical decisions: *J. L. Hodges, Jr.,* and *E. L. Lehmann.* On the existence of least favorable distributions: *E. L. Lehmann.* Sufficient statistics and selection depending on the parameter: *D. A. S. Fraser.* Orthogonal arrays of index unity: *K. A. Bush.* Distribution table for the deviation between two sample cumulatives: *F. J. Massey, Jr.* The stochastic independence of symmetric and homogeneous linear and quadratic statistics: *E. Lukacs.* On a test for homogeneity and extreme values: *D. A. Darling.* On the stochastic and approximation method of Robbins and Monro: *J. Wolfowitz.* Stochastic estimation of the maximum of a regression function: *J. Kiefer* and *J. Wolfowitz.* An asymmetric bell-shaped frequency curve: *F. I. Toranzos.* Remarks on a multivariate transformation: *M. Rosenblatt.*

Biometrics—

September 1952—Sequential experimentation: *R. A. Fisher.* Sequential medical plans: *I. Bross.* The design and interpretation of clinical experiments with drugs: Symposium held jointly by the American Society for Pharmacology and Experimental Therapeutics and the Biometric Society (ENAR), Chairman, W. T. Salter. Tables for convenient calculation of median-effective dose (LD_{50} or ED_{50}) and instructions in their use: *C. S. Weil.*

Econometrica—

October 1952—A survey of the theory of rationing: *J. Tobin.* On a quantitative method in production planning and scheduling: *M. E. Salveson.* The graduation of income distribution: *D. G. Champernowne.* A dynamic model: I. Principles of modern structure: *J. L. Holley.* A continuous model of transportation: *M. Beckmann.* Ordinal preferences

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

or cardinal utility? (with additional notes by G. L. S. Shackle, L. J. Savage and H. Wold): *H. Wold.* The strong independence assumption—gasoline blends and probability mixtures (with additional note by A. Charnes): *A. S. Manne.* Probability, utility, and the independence axiom: *P. A. Samuelson.* Note on von Neumann-Morgenstern's strong independence axiom: *E. Malinvaud.* A set of independent necessary and sufficient conditions for simple majority decision: *K. O. May.* Comments on Solow's "Structure of linear models": *I. N. Herstein.*

Harvard Business Review—

July–August 1952—Cost factors in price-making—Part I: *H. C. Greer.* The significance of productivity data: *J. Diebold.* Plant capacity: too much or too little?: *S. Edmunds.* Retirement programs for industrial workers: *L. J. Ackerman* and *W. C. McKain, Jr.*

Industrial Quality Control—

September—The extra man in the pilot plant: *F. W. Wehrfritz.* The Hamilton Reset-Run card: *D. Shainin.* A study of inspector accuracy: *H. J. Jacobson.* A sensible and flexible control of the percentage defective: *F. E. Satterthwaite.*

November 1952—Circular probability paper: *F. C. Leone* and *C. W. Topp.* The need for statistical quality control in engineering education: *E. G. Olds.* The human factor in quality control: *P. J. Mundie.* Correlation of conventional and accelerated test conditions for heater burnouts by the logarithmic normal distribution: *R. D. Guild.* The operating characteristic of the average chart: *E. P. King.* How to detect the type of an assignable cause. Part 1: Clues for particular types of trouble: *P. S. Olmstead.*

Mathematical Tables and Other Aids to Computation—

July 1952—Use of continued fractions in high speed computing: *D. Teichroew.* On a punched-card method of solving certain integral equations: *B. A. Griffith* and *K. W. Smillie.* The use of exponential sums in step by step integration—II: *P. Brock* and *F. J. Murray.*

October 1952—The office of naval research relay computer: *J. J. Wolf.* On the rounding off of difference tables for linear interpolation: *A. M. Ostrowski.* Mechanical quadrature near a singularity: *Y. L. Luke.* On the numerical solution of equations involving differential operators with constant coefficients: *G. Blanch.*

Milbank Memorial Fund Quarterly—

October 1952—The risk of disability for persons with chronic disease: *J. Downes* and *M. Keller.* Rheumatic fever and streptococcal illness in two communities in New York State: *J. E. Coulter.*

Psychometrika—

June 1952—Finite Markov processes in psychology: *G. A. Miller.* An internal consistency check for the method of successive intervals and the method of graded dichotomies: *A. L. Edwards* and *L. L. Thurstone.* An investigation of the relation of the reliability of multiple-choice tests to the distribution of item difficulties: *F. M. Lord.* Multiple group methods for common-factor analysis: their basis, computation, and interpretation: *L. Guttman.* A technique for facilitating the rotation of factor axes, based on an equivalence between persons and tests: *J. Sandler.*

Quarterly Journal of Economics—

November 1952—Inventory control in theory and practice: *T. M. Whitin.* Accelerated amortization, growth, and net profits: *R. Eisner.* The transactions demand for cash: an inventory theoretic approach: *W. J. Baumol.* A treatment of multiple-process industries: *J. H. Edmonston.*

Review of Economics and Statistics—

August 1952—Toward partial redirection of econometrics: *G. H. Orcutt.* The changing efficiency of the American economy: 1869–1938: *J. Schmookler.* Mr. Colin Clark on the limits of taxation: *J. A. Pechman* and *T. Mayer.* Are farmers getting too much? *L. H. Bean;* Comments: *D. Gale Johnson* and *J. D. Black;* A reply: *L. H. Bean.* Anglo-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

German export competition: *H. Mendershausen.* The consumption function as a tool for prediction: *T. E. Davis.* Secular macroeconomic theorems: *K. K. Kurihara.*

November 1952—National economic accounting: reorientation needed: *J. Margolis.* Actions, consequences, and causal relations: *G. Orcutt.* Elasticity of demand for the exports of a single country: *F. B. Horner.* The prediction of technical change: *S. C. Gilfillan.* The Gerschenkron hypothesis of Index number bias: *I. O. Scott, Jr.*

AUSTRIA—

Statistische Vierteljahresschrift—

Vol. V, Parts 2/3—Kritische Bemerkungen zur Messung der technischen Producktivität: *W. Winkler.* Vorschläge für Produktivitätsmessungen als Bestandteil der Nachkalkulation: *K. P. Vas.* Quantitative Betriebsforschung: *A. Adam.* Über die Qualitätskontrolle: *L. Schmetterer.* Produktivitätssteigerung durch erhöhte Wirtschaftlichkeit im Vertrieb: *R. Grünwald.* Die Entwicklung von Produktion, Beschäftigung und Producktivität in der österreichischen Industrie seit 1945: *S. Koren.*

BELGIUM—

Bulletin de l'Institut de Recherches Économiques et Sociales—

August 1952—Les rémunerations en Belgique de 1936 à 1952: *L-H. Dupriez.* Le travail en double équipe dans l'industrie: *P. Vercruysse.* Les variations du trafic routier belge de 1830 à 1940: *G. Placq.*

November 1952—La grève, phénomène économique et sociologique. Etude inductive des conflits du travail en Belgique de 1920 à 1940: *Y. de Wasseige.* Recherches sur la stratification sociale dans une entreprise : *E. Leemans.*

BRAZIL—

Revista Brasileira de Estatística—

January–March 1952—Componentes ortogonais de uma variação: *E. Amaral.*

FRANCE—

Journal de la Société de Statistique de Paris—

April–June 1952—Variations des prix de 1810 à nos jours: *A. Sauvy.* Évolution de la lettre de change: *P. Cauboue.* Théorie statistique de la mesure et des comparaisons de productivité: *M. Bastenaire.*

Revue d'Économie Politique—

October 1952—L'Économie de l'Union Française d'Outre-mer: (Whole number).

GERMANY—

Mitteilungsblatt Für Mathematische Statistik—

Vol. 4, Parts 2/3—Einige Beiträge der italienischen Schule zur statistischen Methodenlehre: *V. Castellano.* Eine einfache geometrische Veranschaulichung der Theorie des geschichteten Stichprobenverfahrens: *T. Dalenius.* Ein einfacher "ausgewogener Versuch in unvollständigen Blöcken": *A. Linder.* Ökonometrische Berechnungen im Grossen: *O. Morgenstern.* Die Paretosche und die Lorenzsche kumulative Verteilungskurve der Individuellen Einkommen: *S. Sagaraoff.* Die Anwendung der Variate Difference Methode auf die Probleme der gewogenen Regression und der Multikollinearität: *G. Tintner.* Über gleichmässige Interkorrelation: *H. Wold.* Logisch-philosophische Bemerkungen zur Axiomatik der Wahrscheinlichkeitslehre: *W. Britzelmayr.* Einige Ergebnisse der Betrachtungsweise auf der Struungsstufe (Streuungskalkül): *H. Gebelein.* Wahrscheinlichkeitsprobleme im Fernsprechverkehr: *G. Gomm.* Mehrdimensionale Operationscharakteristiken: *U. Graf* and *H-J. Henning.* Marktforschung—ein Anwendungsgebiet des Stichprobenverfahrens: *H. Kellerer.* Ein statistisches Problem in Theorie und Praxis: *W. Ludwig, R. Wartmann* and *R. Wette.* Inhalt und Grenzen ökonometrischer Erkenntnis: *W. Mahr.* Anwendung von Stichprobenverfahren zur Erfassung der Schweinebestände in Bayern: *H. Strecker.* Bemerkungen über nomographische Verfahren zur rationellen SequentialtestPlanung: *G. Wünsche.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Weltwirtschaftliches Archiv—

Vol. 69, Part 1—The influence of Keynesian thinking in the United States: *A. H. Hansen.* Produktivität und Beschäftigung: *A. Sauvy.* Regional economic development in the United States: *G. J. Hile* and *W. Stolper.* Current developments in regional analysis: *W. Isard.*

ITALY—

Giornale degli Economisti e Annali di Economia—

May–June 1952—La gestione della tesoreria dello stato durante e dopo la seconda guerra mondiale: *F. A. Répaci* Che cosa è la cosidetta "età' estrema"?: *F. Insolera.* Teoria matematica dei premi all'esportazione: *G. Sensini.*

July–August 1952—Limiti all'applicazione del teorema e del postulato di Bayes e della regola di Laplace alle comuni forme del ragionamento economico: *G. Demaria.*

Statistica—

July–September 1952—Appunti sulle misure statistiche della variabilità: *P. Fortunati.* A proposito di un'indagine sulle forze di lavoro: *A. Bellettini.* Sulla misure della tendenza nel tempo della sperequazione economica regionale: *G. Cusimano.*

JAPAN—

Annals of the Institute of Statistical Mathematics—

Vol. III, No. 2—On practical systematic sampling: *H. Aoyma.* On Midzuno's inequality: *H. Aoyama.* On the prediction of phenomena from qualitative data and the quantification of qualitative data from the mathematico-statistical point of view: *C. Hayashi.* On the sampling system with probability proportionate to sum of sizes: *H. Midzuno.* Report of the Survey Design for Agricultural Production Estimates in Ryukyu Islands: *H. Midzuno.* On the Poisson-Gamma distribution problem: *L. A. Goodman.*

SWEDEN—

Skandinavisk Aktuarietidskrift—

Parts 1–2 1952—The limit distribution of a continuous function of random variables: *E. Sverdrup.* Large sample validity of the binomial distribution for lives with unequal mortality rates: *J. E. Walsh.* A semi-convergent series with application to the collective theory of risk: *G. Arfwedson.* Inequalities in Makeham-graduated Tables: *J. F. Steffenson.* Some results in time series analysis: *P. Whittle.* The problem of optimum stratification in a special type of design: *T. Dalenius.*

SWITZERLAND—

Mitteilungen der Vereinigung schweizerischer Versicherungsmathematiker—

Vol. 52, Part 2—Schweizerische Volkssterbetafeln 1939/44 nach Landesteilen: *Eidgenössisches Statistisches Amt, Bern.* Prämien und Deckungskapitalien in der Todesfallversicherung, wenn die Beiträge nur bis zum Todestag geschuldet sind: *E. Zwinggi.* Noch einige praktische Interpolationsformeln des Zinsfussproblemes von hoher Präzision: *I. Lah.*

INTERNATIONAL—

International Labour Review—

September 1952—International migration and European population trends: *J. Isaac.*

Revue de l'Institut International de Statistique—

Vol. 20, No.1—The business test of the IFO-Institute for Economic Research, Munich, and its theoretical model : *O. Anderson.* Major and minor problems in the estimates of national income: *C. Gini.* Les limites d'une importante critique à la démographie potentielle, avec réponse de J. Bourgeois-Pichat et conclusions de L. Hersch: *L. Hersch.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part IV, 1952, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

United Kingdom. *Board of Trade.* Assurance Companies Acts 1909–1946: summary of statements of assurance business deposited with the Board of Trade during the year ended 31st December, 1951. London, H.M.S.O., 1952. 48 pp. 12″. 5*s*.

Report of the Copyright Committee. London, H.M.S.O., 1952. ii, 130 pp. 9½″. 4*s*. 6*d*. Cmd. 8662.

Central Statistical Office. The index of industrial production. London, H.M.S.O., 1952. 1 p.l., 54 pp. 8¼″. 2*s*. 6*d*. (Studies in Official Statistics, 2.)

Colonial Office. Report ... on the administration of the Cameroons under United Kingdom trusteeship for the year 1951. London, H.M.S.O., 1952. xii, 260 pp. photos, maps. 9½″. 15*s*. (Colonial 288.)

Commonwealth Economic Committee. A survey of the trade in agricultural machinery. London, H.M.S.O., 1952. vi, 174 pp. 9½″. 7*s*. 6*d*. (Report 36.)

Forestry Commission. Census report no. 1. Census of woodlands 1947–1949: woodlands of five acres and over. London, H.M.S.O., 1952. 264 pp. 9½″. 12*s*. 6*d*.

General Register Office. Census 1951 Great Britain: one per cent sample tables ... Part II. Characteristics and composition of private households, non-private households, education, birthplace and nationality, fertility, Welsh and Gaelic languages, conurbation supplement. London, H.M.S.O., 1952. 4 p.l., 161–367, xix pp. maps. 13″. 40*s*.

Meteorological Office. Climatological atlas of the British Isles. London, H.M.S.O., 1952. iv, 139 pp. incl. plates. front. 12″. 52*s*. 6*d*. (M.O. 488.)

Ministry of Food. Domestic food consumption and expenditure, 1950, with a supplement on food expenditure by urban working-class households, 1940–1949: annual report of the National Food Survey Committee. London, H.M.S.O., 1952. 131 pp. 9½″. 4*s*. 6*d*.

Ministry of Fuel and Power. Report of the Committee on national policy for the use of fuel and power resources ... London, H.M.S.O., 1952. v, 242 pp. 9¾″. 6*s*. 6*d*. Cmd. 8647.

Ministry of Health. National Health Service Act, 1946: hospitals' directory England and Wales, 1952. London, H.M.S.O., 1952. v, 276 pp. map. 9¾″. 10*s*. 6*d*.

National health service hospital and specialist services England and Wales: statistics for the year ended 31st December 1950. London, H.M.S.O., 1952. [ii], 253 pp. 12¾″. 20*s*.

Ministry of Housing and Local Government. The density of residential areas. London, H.M.S.O., 1952. iv, 71 pp. fold. tables. 9½″. 5*s*.

Ministry of Transport. Road traffic census 1950: report including tables of statistics of traffic recorded on trunk, class I & class II roads in Great Britain at selected census points taken in August 1950. London, H.M.S.O., 1952. iv, 35 pp. 13″. 5*s*.

National Physical Laboratory. Recent developments and techniques in the maintenance of standards. London, H.M.S.O., 1952. iv, 100 pp. photos. 9½″. 4*s*. 6*d*.

Select Committee on Nationalised Industries. Report from the Select Committee on Nationalised Industries: together with the proceedings of the Committee, minutes of evidence and appendices. London, H.M.S.O., 1952. xxvi, 140 pp. 9½″. 6*s*. 6*d*.

Treasury. United Kingdom balance of payments 1949 to 1952. London, H.M.S.O., 1952. 39 pp. 9½″. 1*s*. 6*d*. Cmd. 8666.

Australia. *Bureau of Agricultural Economics.* The Papuan rubber industry. Canberra, 1952. 3 p.l., 33 pp. 8½″. (Bulletin, 7.)

Commonwealth Bureau of Census and Statistics. Census of the Commonwealth of Australia. 30th June, 1947. Part XVII.—Industry. Canberra, [1952]. 932–1325 pp. 13¼″. 2*s*. 6*d*. (C.S. 850.)

Belgium. *Institut National de Statistique.* Recensement général de la population, de l'industrie et du commerce au 31 décembre 1947. Tome XII. Salaires dans le commerce. Bruxelles, A. Puvrez, 1951. 229 pp. 11½″.

Recensement général de la population, de l'industrie et du commerce au 31 décembre 1947. Tome XIII. Recensement des diplômés de l'enseignement supérieur. Bruxelles, Fr. van Muysewinkel, 1952. 79 pp. 11½″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Food and Agriculture Organization. F.A.O. Commodity Series no. 20. Tobacco. Rome, 1952. 3 p.l., 49 pp. 11″. 2*s.* 6*d.*

Germany. *Statistisches Bundesamt.* Statistik der Bundesrepublik Deutschland. 10. Die Bundestagswahl am 14. August 1949. [1952]. 58 pp. 11¾″. 16. Handwerkszählung vom 30.9. 1949. Bd. 6. Textliche Auswertung der Ergebnisse. [1952]. 40 pp. 11¾″. 19. Die kommunalen Finanzen im Rechnungsjahr 1949, Teil 2. 1952. 247 pp. 11¾″. 21. Grössen- und Besitzverhältnisse der land- und forstwirtschaftlichen Betriebe. Heft 2. Ergebnisse der landwirtschaftlichen Betriebszählung vom 22. Mai 1949 und der Zählung der landwirtschaftlichen Kleinbetriebe vom 13. September 1950. [1952]. 279 pp. 11¾″. 23. Personalverhältnisse in den land- und forstwirtschaftlichen Betrieben: Ergebnisse der landwirtschaftlichen Betriebszählung vom 22 Mai 1949. [1952]. 413 pp. 11¾″. 25. Maschinenverwendung in den land- und forstwirtschaftlichen Betrieben. Heft 1. Ergebnisse der landwirtschaftlichen Betriebszählung vom 22. Mai 1949. Heft 2. Ergebnisse der Schlepperhebung vom 14. April 1950. 1952. 2 vols. 11¾″. 33. Amtliches Gemeindeverzeichnis für die Bundesrepublik Deutschland: entgültige Ergebnisse nach der Volkszählung vom 13.9.1950. [1952]. vi, 344 pp. map. 11¾″. 35. Die Bevölkerung der Bundesrepublik Deutschland nach der Zählung vom 13.9.50. Heft 2. Die Bevölkerung nach der Religionszugehörigkeit. [1952]. 27 pp. maps. 11¾″. 54. Die staatlichen Finanzen im Rechnungsjahr 1949. [1952]. 195 pp. 11¾″. 55. Personal der öffentlichen Verwaltung am 2.9.1950. [1952]. 88 pp. 11¾″. 60. Die Kapital- und Bilanzumstellungen der Aktiengesellschaften. [1952]. 60 pp. 11¾″. 61. Gesundheitswesen: statistische Ergebnisse 1946–1950. [1952]. 117 pp. 11¾″. 62. Die natürliche Bevölkerungsbewegung in den Jahren 1946–1949. [1952]. 83 pp. 11¾″. 63. Die natürliche Bevölkerungsbewegung im Jahre 1950. [1952]. 51 pp. 11¾″. 66. Das Bauhauptgewerbe im Juli 1951 (Ergebnisse der Totalerhebung). [1952]. 24, 65 pp. 11¾″. 68. Die Seeschiffahrt im Jahre 1950. [1952]. xvii, 108 pp. map. 11¾″. 69. Die Güterbewegung auf den Eisenbahnen im Jahre 1950. [1952]. xvii, 637 pp. map. 11¾″. 71. Die Viehwirtschaft 1951. [1952]. 49 pp. 11¾″. Stuttgart-Köln, W. Kohlhammer.

Italy. *Instituto Centrale di Statistica.* Classificazioni delle malattie e cause di morte; deliberate dalla vi. Conferenza Internationale per la Revisione delle Nomenclature Nosologiche (Parigi, 26–30 aprile 1948). Roma, F. Failli, 1952. 274 pp. 8¾″.

Japan. *Bureau of Statistics.* Population census of 1950. Vol. II. Results of one percent sample tabulation. [Tokyo, 1952]. 2 p.l., iv, 84 pp. diagrs. 10″.

New Zealand. *Census and Statistics Department.* Population census, 1945. Vol. VII. Birthplaces and duration of residence of overseas-born. Wellington, 1952. v, 47 pp. 12¼″. 10*s.*

Population census, 1945. Vol. XI. Dwellings and households. Wellington, 1952. 2 p.l., ii, 81 pp. 12¼″. 15*s.*

Organisation for European Economic Co-operation. Chemical apparatus in the U.S.A.; report by a group of European experts. Paris, 1952. 224 pp. photos., diagrs. 9½″. (Technical Assistance Mission, 23.)

Cost accounting and productivity: the use and practice of cost accounting in the U.S.A.; report by a group of European experts. Paris (London, H.M.S.O.), 1952. 125 pp. 9½″. (Technical Assistance Mission, 50.)

Sulphur; a study by the Secretariat of the Chemical Products Committee. Paris, 1952. 62 pp. 9½″.

Spain. *Instituto Nacional de Estadistica.* Tablas de mortalidad de la poblacion española años 1900 a 1940. Madrid, 1952. 131 pp. 6 graphs. 9½″.

Sweden. *Byggnadsverksamhet och Bostadsförhållanden.* Bostäder och hushåll: enligt allmänna bostadsräkningen 1945 och därtill anslutna undersökningar; av kungl. Socialstyrelsen. [Stockholm, 1952.] 220 pp. 9¼″.

Switzerland. *Bureau fédéral de Statistique.* Tables de mortalité de la population suisse 1931–41 & 1939–44. La mortalité en Suisse & son évolution. Berne, 1952. 80 pp. tables. annexe, 63 pp. 11¾″. (Statistiques de la Suisse—232e. fasc., sér. Bk 4.)

U.N. Educational, Scientific & Cultural Organization. World handbook of educational organization and statistics. 1st ed. 1951. Paris, 1951. 469 pp. 10½″. 51*s.* 6*d.* bd. 35*s.* paper.

United States of America. *National Bureau of Standards.* Tables for the analysis of beta spectra. Washington, Superintendent of Documents, 1952. iii, 61 pp. 10¼″. 35*c.* (Applied Mathematics Series, 13.)

Tables of Coulomb wave functions, vol. I. Washington, Superintendent of Documents, 1952. xxvii, 141 pp. 10¼″. $2.00. (Applied Mathematics Series, 17.)

Tables of the Bessel functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$, $0 \leq x \leq 1$. Washington, Superintendent of Documents, 1952. ix, 60 pp. 10¼″. 40*c.* (Applied Mathematics Series, 25.)

Office of Statistical Standards. Statistical services of the United States Government. Rev. ed. Washington, 1952. 1 p.l., 78 pp. 10″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

World Health Organization. Expert Committee on Mental Health. Alcoholism subcommittee. Second report. Geneva, 1952. 39 pp. 9½″. 2*s*. (World Hlth. Org. Techn. Rep. Ser., 1952, 48.)

II.—AUTHORS AND MISCELLANEOUS

Abruzzi (Adam). Work measurement: new principles and procedures. New York, Columbia University Press (London, Geoffrey Cumberlege), 1952. xviii, 290 pp. 9″. 40*s*.

Adler (John H.), Schlesinger (Eugene R.) & Van Westerborg (Evelyn). The pattern of United States import trade since 1923: some new index series and their application. New York, Federal Reserve Bank, 1952. 136 pp. 10″.

Angelopoulos (Angelos). Planisme et progrès social. Paris, Librairie Générale de Droit et de Jurisprudence, 1953. 403 pp. 8¾″. 1,200 *f*.

Batchelor (James H.). Operations research: a preliminary annotated bibliography. Cleveland, Ohio, Case Institute of Technology, 1952. 95 pp. 8½″. $1.

Behrens (D. J.). The statistical significance of counts differing only slightly from the mean background level. London, H.M.S.O., 1952. 1 p.l., 4, [2] pp. 12¾″. 1*s* 6*d*. (A.E.R.E. T/R 640.)

Bennett (Merrill K.). Population, food, and economic progress. Houston, Texas, The Rice Institute, 1952. 68 pp. 9″. (Pamphlet, 39, no. 2.)

Berridge (William A.). Life insurance and the national economy: two reminiscent studies of some likes and unlikes between 1929 and now. *The Spectator* [U.S.A.] (1952), January and May. [8] p. 11″.

Birmingham. City of Birmingham annual abstract of statistics. No. two 1950–1951; ed. by Richard Padley ... and Wallis Taylor ... City of Birmingham Central Statistical Office, [1952]. xiii, 140 pp. 11″. 10*s*.

Blacker (C. P.), *editor*. Problem families: five inquiries. London, Eugenics Society, 1952. 1 p.l., 123 pp. 8½″. 5*s*.

Borneman (Roy) & Hughes (Percy F.). Excess profits levy law and practice: a comprehensive survey of the levy. London, Taxation Publishing Co., 1952. xix, 344 pp. 8½″. 21*s*.

Brandt (Karl). American agricultural policy during rearmament. Stanford University, Food Research Institute, 1951. 19 pp. 8½″.

British Association for the Advancement of Science. Mathematical tables, volume X. Bessel functions, part II. Functions of positive integer order ... London, C.U.P., for the Royal Society, 1952. xl, 255 pp. 11″. 60*s*.

Britton (S. C.). The corrosion resistance of tin and tin alloys. Greenford, Mddx., Tin Research Institute, 1952. 77, v pp. 9¾″. 3*s*. 6*d*.

Brookes (B. C.). Notes on the teaching of statistics in schools. London [etc.], Heinemann, [1952]. viii, 80 pp. 7¼″. 5*s*.

Cambridge University Department of Applied Economics. Company accounting; by F. Sewell Bray. *J. Soc. Statist. Inquiry Soc. Ireland* (1952). 22 pp. 9½″. (Reprint Series, 61).

Compensated changes in quantities and qualities consumed; by H. S. Houthakker. *Rev. Econ. Studies* (1952). 10 pp. 9¾″. (Reprint Series, 62.)

Irreversible demand functions; by M. J. Farrell. *Econometrica* (1952), 171–186. 10″. (Reprint Series, 63.)

The econometrics of family budgets; by H. S. Houthakker. *J. R. Statist. Soc.* (1952), **115**, 1–28. 9¾″. (Reprint Series, 64.)

Coe (N. E.) & Ogborn (M. E.). The practice of life assurance: a text-book for actuarial students. C.U.P., 1952. x, 440 pp. 8½″. 32*s*.

Cope (V. Zachary), *editor*. Medicine and pathology. London, H.M.S.O., 1952. xxix, 565 pp. 9½″. 50*s*. (History of the Second World War, U.K. Medical Series.)

Copeland (Morris A.). A study of money flows in the United States. [New York], National Bureau of Economic Research, [1952]. xxxii, 338 pp. Appendix, 241 p. diagrs. 9¼″. $7.50. (Publication, 54.)

Cox (D. R.). A note on the sequential estimation of means. *Proc. Camb. Phil. Soc.* (1952), **48**, 447–450. 10″.

Sequential tests for composite hypotheses. *Proc. Camb. Phil. Soc.* (1952), **48**, 290–299. 10″.

Some systematic experimental designs. *Biometrika* (1951), **38**, 312–323. 10¾″.

Currie (Lyndesay M.). Consequential fire loss insurance in the United Kingdom and Eire. London, Gee, 1952. iv, 178 pp. 8½″. 21*s*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Daniels (H. E.). The covering circle of a sample from a circular normal distribution. *Biometrika* (1952), **39**, 137–143. $10\frac{3}{4}''$.

The statistical theory of stiff chains. *Proc. Roy. Soc. Edinb.*, A (1952), **63**, 290–311. $10''$.

Davis (J. S.). Our changed population outlook and its significance. *Amer. Econ. Rev.* (1952), **42**, 304–325. $9\frac{1}{4}''$.

Davis (Joseph S.). Utilization of population centers as investment wells. *Analysts J.* (1952), March. [3] pp.

Drolet (Godias J.) & Lowell (Anthony M.). Whither tuberculosis?: a statistical review of reports from selected American and European communities. *Dis. Chest* (1952), **21**, p. 527. 37 pp. $9\frac{3}{4}''$.

Dublin (Louis I.). A 40 year campaign against tuberculosis. New York, Metropolitan Life Insurance Company, 1952. v, 115 pp. $9''$.

Dunn (C. L.). The emergency medical services ... Vol. I. England and Wales. London, H.M.S.O., 1952. xvi, 460 pp. photos. $9\frac{1}{2}''$. 50*s*. (History of the Second World War, U.K. Medical Series.)

Ehrenberg (A. S. C.). Note on normal transformations of ranks. *Brit. J. Psychol. Statist. Sect.* (1951), **4**, 133–134. $9\frac{3}{4}''$.

On sampling from a population of rankers. *Biometrika* (1952), **39**, 82–87. $10\frac{3}{4}''$.

Eisenhart (Churchill). Operational aspects of instrument design. *Science* (1949), **110**, 343–346.

The reliability of measured values—Part I. Fundamental concepts. *Photogramm. Engng.* (1952), 542–561. $10''$.

The role of a statistical consultant in a research organization. *Proc. Int. Statist. Conf.* (1947), 3, 308–313. $9\frac{1}{2}''$.

Elderton (Sir William P.) & Elderton (Ethel). Primer of statistics. London, A. & C. Black, 1943. vii, 86 pp. front. $7''$. 6*s*.

Emmett (W. G.). An inquiry into the prediction of secondary-school success. London University Press, 1942. 58 pp. $7\frac{1}{4}''$.

Fabricant (Solomon). The trend of Government activity in the United States since 1900. New York, National Bureau of Economic Research, 1952. xix, 267 pp. $9''$. $4. (Publication, 56.)

Federation of British Industries. Computation of trading profits for taxation purposes: comment on the report of the Millard Tucker Committee. London, 1952. 1 p.l., 26 pp. $8\frac{1}{2}''$.

Finney (D. J.). Can we avoid statistics? *Ann. Soc. R. Méd. Nat. Bruxelles* (1952), **5**, 54–64. $9\frac{1}{2}''$.

The equilibrium of a self-incompatible polymorphic species. *Genetica* (1952), **26**, 33–64. $9\frac{1}{2}''$.

Fourastié (Jean). Le grand espoir du XXe siècle ... 3e éd. Paris, Presses Universitaires de France, 1952. xxviii, 245 pp. $9''$. 320 *f*.

La productivité. Paris, Presses Universitaires de France, 1952. 119 pp. $7''$. 150 *f*.

Freedman (Ronald) & Whelpton (P. K.). Social and psychological factors affecting fertility. XV. Fertility planning and fertility rates by adherence to traditions. *Milbank Mem. Fd. Quart. Bull.* (1952), **30**, 61–90. $9''$.

Freund (John E.). Modern elementary statistics. New York, Prentice-Hall, 1952. x, 418 pp. $8\frac{1}{4}''$.

Gibson (J. W.) & *others*. Procedures for assessing the relative safety of explosives and of coal dust/inert dust mixtures by means of gallery experiments; by J. W. Gibson, H. C. Grimshaw & D. W. Woodhead ... Buxton, The Seventh International Conference of Directors of Safety in Mines Research, 1952. 46 pp. incl. tables. $9\frac{1}{2}''$. (Paper 29.)

Goheen (Howard W.) & Kavruck (Samuel). Selected references on test construction mental test theory and statistics 1929–1949. Washington, Supt. of Documents, 1950. xii, 209 pp. $9''$. $1.50.

Good (I. J.). Skin banks. *Lancet* (1952), 289. 3 pp. $7\frac{1}{4}''$.

Goulden (Cyril H.). Methods of statistical analysis. 2nd ed. New York, Wiley (London, Chapman & Hall), [1952]. vi, 1 p.l., 467 pp. $9''$. 60*s*.

Grundy (P. M.). The expected frequencies in a sample of an animal population in which the abundance of species are log-normally distributed. Part I. *Biometrika* (1951), **37**, 427–434. $10\frac{3}{4}''$.

Hald (A.). Statistical tables and formulas. New York, Wiley (London, Chapman & Hall), 1952. 97 pp. $11''$. 20*s*.

Statistical theory with engineering applications. New York, Wiley (London, Chapman & Hall), 1952. xii, 783 pp. $10''$. 72*s*.

Statistiske metoder med eksempler paa anvendelser indenfor teknikken. København, Det Private Ingeniørfond, 1948. [x], 654 pp. $10''$. 70*s*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Statistiske metoder: tabel- og formelsamling. København, Det Private Ingeniørfond, 1948. 77 pp. $11\frac{1}{4}''$.

Hammersley (J. M.). An extension of the Slutzky-Fréchet theorem. *Acta Math., Stockh.* [1952], **87**, 243–257. $11\frac{3}{4}''$.

The computations of sums of squares and products on a desk calculator. *Biometrics* (1952), **8**, 156–168. $9\frac{1}{4}''$.

Lagrangian integration coefficients for distance functions taken over right circular cylinders. *J. Math. Phys.* (1952), **31**, 139–150. $10''$.

Hargreaves (Eric L.) & Gowing (M. M.). Civil industry and trade. London, H.M.S.O. and Longmans, Green, 1952. xii, 678 pp. $9\frac{1}{2}''$. 37*s.* 6*d.* (History of the Second World War, U.K. Civil Series.)

Hartree (D. R.). Numerical analysis. Oxford, Clarendon Press, 1952. xiv, 287 pp. $9\frac{1}{4}''$. 30*s.*

Hawtrey (R. G.). Capital and employment. 2nd ed. London, Longmans, Green, 1952. viii, 337 pp. $8\frac{1}{2}''$. 40*s.*

Hickman (W. Braddock). Trends and cycles in corporate bond financing. New York, National Bureau of Economic Research, 1952. 3 p.l., 37 pp. $9''$. $75. (Occasional Paper, 37.)

Hill (A. Bradford). The clinical trial. *New Engl. J. Med.* (1952), **247**, 113–119. $11''$.

Hill (George W.) & Tarver (James D.). Marriage and divorce trends in Wisconsin, 1915–1945. *Milbank Mem. Fd. Quart. Bull.* (1952), **30**, 5–17. $9''$.

Hulton Research. The Hulton readership survey 1952 ... Compiled by J. W. Hobson . . . and H. Henry ... Technique of sampling and execution of field work under the direction of M. A. Abrams ... London, Hulton Press, 1952. 56 pp. $17\frac{1}{2} \times 13\frac{1}{4}''$.

Institute of Bankers. Banking and foreign trade: being the lectures delivered at the fifth International Banking Summer School, Christ Church, Oxford, July 1952. London, Europa Publications [1952]. 259 pp. $8\frac{1}{2}''$. 15*s.*

Institute of Cost and Works Accountants & Institution of Production Engineers. Measurement of productivity: work study application and training ... London, Gee, [1952]. 62 pp. $9''$. 5*s.*

Inter American Statistical Institute. Bibliography of statistical textbooks and other teaching material . . . *Estadistica* (1952), **10**, Supl. 2, 623–669. $9''$.

International Association for Research in Income and Wealth. Income & wealth of the United States: trends and structure. Income and wealth, Series II: papers by Simon Kuznets & Raymond Goldsmith; ed. by Simon Kuznets. Cambridge, Bowes & Bowes, [1952]. vii, 9–328 pp. $8\frac{1}{2}''$. 35*s.* (Income & Wealth, Series 1.)

International Tin Study Group. Statistical yearbook 1952: tin, tinplate, canning. [The Hague], International Tin Study Group, 1952. 266 pp. $10\frac{1}{2}''$. 40*s.*

Isaac (Julius). International migration and European population trends. *Int. Labour Rev.* (1952), **66**, no. 3. 24 pp. $9\frac{1}{2}''$.

Jasny (Naum). A close-up of the Soviet fourth five-year plan. *Q. J. Econ.* (1952), **66**, 139–171. $9\frac{1}{4}''$.

Discussion: Kolkhozy, the Achilles' heel of the Soviet régime. *Soviet Studies* (1951), **3**. 14 pp. $9\frac{3}{4}''$.

Labor and output in Soviet concentration camps. *J. Pol. Econ.* (1951), **59**, 405–419. $9\frac{1}{2}''$.

Soviet grain crops and their distribution. *Int. Affairs* (1952), **28**, 452–459. $9\frac{3}{4}''$.

Johnston (Bruce F.). Agricultural productivity and economic development in Japan. *J. Pol. Econ.* (1951), **59**, 498–513. $9\frac{1}{2}''$.

Jones (D. T.). Speeds and normal accelerations of Boeing Clipper aircraft on North and South Atlantic routes. London, H.M.S.O., 1952. 14 pp. $12''$. 4*s.* (Aeronautical Research Council Reports and Memoranda, 2633.)

Kemsley (W. F. F.). Body weight at different ages and heights. *Ann. Eugen.* (1952), **16**, 316–334. $10\frac{3}{4}''$.

Kohan (C. M.). Works and buildings. London, H.M.S.O. and Longmans, Green, 1952. xvi, 540 pp. $9\frac{1}{2}''$. 32*s.* 6*d.* (History of the Second World War, U. K. Civil Series.)

Korzybski (Stanislas). Le peuplement des grandes agglomérations urbaines: Londres et Paris aux XIXe et XXe siècles. Population (1952), **7**, 485–520. $9\frac{1}{4}''$.

Kottler (F.). The goodness of fit and the distribution of particle sizes. *J. Franklin Inst.* (1951), **251**, 499–514, 617–642. $9\frac{1}{2}''$.

Lancaster (H. O.). Australian life tables, from a medical point of view. *Med. J. Aust.* (1951), 251–257. $11''$.

Deafness as an epidemic disease in Australia: a note on census and institutional data. *Brit. Med. J.* (1951), 2, 1429. 11 pp. $8\frac{1}{2}''$.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Mortality from congenital malformations in Australia. *Med. J. Aust.* (1951), 318–320. 11″.

The mortality in Australia from acute infective disease. *Med. J. Aust.* (1952), 175–180. 10¾″.

Levinson (Horace C.). The science of chance from probability to statistics. London, Faber & Faber, [1952]. 304 pp. 8½″. 30*s.*

Lewis (Edward E.). Methods of statistical analysis in economics and business. Boston, New York, Houghton Mifflin, [1953]. viii, 686 pp. 9¼″. $5.50.

Lindley (D. V.). The theory of queues with a single server. *Proc. Camb. Phil. Soc.* (1952), **48**, 277–289. 10″.

Lloyd (E. H.). Least-squares estimation of location and scale parameters using order statistics. *Biometrika* (1952), **39**, 88–95. 10¾″.

On the estimation of variance and covariance. *Proc. Roy. Soc. Edinb.*, A (1950–51), **63**, 280–289. 10″.

London School of Economics and Political Science. Division of Research Techniques. The geometry of estimation; by J. Durbin and M. G. Kendall. *Biometrika* (1951), **38**, 150–158. 10″. (Reprint Series, 6.)

Some questions of distribution in the theory of rank correlation; by S. T. David, M. G. Kendall and A. Stuart. *Biometrika* (1951), **38**, 131–140. 10″. (Reprint Series, 7.)

A review of the literature of systematic sampling; by W. R. Buckland. *J. R. Statist. Soc.*, B (1951), **13**, 208–215. 10″. (Reprint Series, 13.)

Inversions and rank correlation coefficients; by J. Durbin and A. Stuart. *J. R. Statist. Soc.*, B (1951), **13**, 303–309. 10″. (Reprint Series, 14.)

Regression, structure and functional relationship, part II; by M. G. Kendall. *Biometrika* (1952), **39**, 96–108. 10″. (Reprint Series, 15.)

Moment statistics in samples from a finite population; by M. G. Kendall. *Biometrika* (1952), **39**, 14–16. 10″. (Reprint Series, 16.)

Long (Clarence D.). The labor force in war and transition: four countries ... New York, National Bureau of Economic Research, 1952. 3 p.l., 61 pp. 9″. $1. (Occasional Paper, 36.)

Lyon, Université de. Annales de l'Université de Lyon, troisième série, fasc. 14. Section A. Sciences mathématiques et astronomie XIV. Paris, Masson, 1951. 149 pp. 10″.

McKinsey (J. C. C.). Introduction to the theory of games. New York, London, McGraw-Hill, 1952. x, 371 pp. 9″. 55*s.* 6*d.*

Mehta (J. K.) & *others*. Fundamentals of economics. 2nd ed. Allahabad, Pothishala, 1951. 3 p.l., ii, 840, ix pp. 9¾″. *Rs.* 12/8/–.

Mills (Frederick C.). Productivity and economic progress. [New York], National Bureau of Economic Research, 1952. 4 p.l., 36 pp. 9″. (Occasional Paper, 38.)

Monkhouse (F. J.) & Wilkinson (H. R.). Maps and diagrams: their compilation and construction. London, Methuen, [1952]. xvi, 330 pp. maps, diagrs. 8½″. 25*s.*

Montello (Jessé). A renovação dos segurados de uma caixa: a transformação de Laplace. Rio de Janeiro, Editora Finanças e Seguros, 1949. 3 p.l., 105, [3] pp. 9″.

Mothes (J.). Techniques modernes de contrôle des fabrications. Tome I. Les applications classiques de la statistique à la recherche et au contrôle industriels. Paris, Dunod, 1952. xiv, 547 pp. 9½″.

National Bureau of Economic Research. Conference on research in income and wealth. New York, 1952. x, 230 pp. 9″. $3.50. (Studies in Income and Wealth, 15.)

Conference on research in business finance; held under the auspices of Universities-National Bureau Committee for Economic Research. New York, 1952. xviii, 340 pp. 9″. $5. (Special Conference Series, 3.)

Pearce (S. C.). The design of calibration trials with three varieties. *Rep. E. Malling Res. Sta.* (1951), 105–107. 9¾″.

Studies in the measurement of apple trees. 1. The use of trunk girths to estimate tree size. *Rep. E. Malling Res. Sta.* (1951), 101–104. 9¾″.

Pearce (S. C.) & Thom (Jean M. S.). A study of plot-size with Nigerian estate cacao. *J. Hort. Sci.* (1951), **26**, 261–267. 9½″.

Pember & Boyle. British government securities in the twentieth century: supplement. London, 1952. [21], 217 pp. 8″ × 13″.

Perks (Frank W.). Modern secretarial knowledge (company work, meetings and business management.) 3rd ed. London, Gee, 1952. xiii, 309 pp. 8½″. 25*s.*

Postan (M. M.). British war production. London, H.M.S.O. and Longmans, Green, 1952. xvi, 512 pp. 9½″. 32*s.* 6*d.* (History of the Second World War, U.K. Civil Series.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Quenouille (M. H.). Associated measurements. London, Butterworth, 1952. x, 242 pp. 10″. 35*s.*

Rao (C. Radhakrishna). Advanced statistical methods in biometric research. New York, Wiley (London, Chapman & Hall), [1952]. xvii, 390 pp. 9″. 60*s.*

Reading, University of. Department of Agricultural Economics. Financial results of 33 poultry flocks in Southern England during 1950–1951; by J. A. Mollett ... Reading, 1952. 20 pp. 8½″ × 13″. 2*s.* (Miscellaneous Cost Studies, 22.)

Cost and returns from wheat production on 41 farms in the south of England in 1950–1951; by Ian G. Reid. Reading, 1952. 7 pp. 10″. 2*s.* (Miscellaneous Cost Studies, 23.)

Costs and returns from milk production in the southern province in 1950/1951; by R. S. Cook. Reading, 1952. 29 pp. 10″. 2*s.* (Miscellaneous Cost Studies, 24.)

Redding (A. David). Reliability of estimates of unfree labor in the U.S.S.R. *J. Pol. Econ.* (1952), **60**, 337–342. 9½″.

Rhys-Williams (Lady). Taxation and incentive. London [etc.] W. Hodge, 1953. 188 pp. 8½″. 15*s.*

Ricardo (David). The works and correspondence of David Ricardo; edited by Piero Sraffa with the collaboration of M. H. Dobb. C.U.P., for The Royal Economic Society, 1952. 4 vols. 9″. 24*s.* each. Vol. 6. Letters 1810–1815. Vol. 7. Letters 1816–1818. Vol. 8. Letters 1819–1821. Vol. 9. Letters 1821–1823.

Rose (T. G.). Company control. London, Gee, 1952. 40 pp. 8½″. 10*s.* 6*d.*

Rostas (L.). Select bibliography on productivity (provisional edition). London, Board of Trade, 1952. 20 pp. 8″.

Sampford (M. R.). The estimation of response-time distributions. 1. Fundamental concepts and general methods. *Biometrics* (1952), **8**, 13–32. 9¼″.

Smithsonian Institution. Research Corporation Fund. Smithsonian logarithm tables to base e and base 10. Washington, 1952. xii, 1 p.l., 402 pp. 9″. (Miscellaneous Collections, 118, whole vol., Publication 4054.)

Sovani (N. V.). Social survey of Kolhapur City. Vol. II. Industry, trade & labour. [Poona], Gokhale Institute of Politics and Economics, 1951. 1 p.l., x, 346 pp. maps. 8½″. 18*s.* (Publication 23.)

Social survey of Kolhapur City. Vol. III. Family living & social life. [Poona], Gokhale Institute of Politics and Economics, 1952. xiv, 330 pp. 8½″. 18*s.* (Publication 24.)

Staveley (Ronald), *editor.* Government information and the research worker: lectures delivered at a vacation course of the University of London School of Librarianship and Archives in April 1951. London, Library Association, 1952. vi, 228 pp. 8½″. 24*s.*

Sukhatme (P. V.) & Panse (V. G.). Crop surveys in India—II. *J. Indian Soc. Agric. Statist.* (1951), **3**, 97–168. 9¾″.

Sukhatme (P. V.) & Seth (G. R.). Non-sampling errors in surveys. *J. Indian Soc. Agric. Statist.* (1952), **4**, 5–41. 9¾″.

Sukhatme (P. V.) & Narain (R. D.). Sampling with replacement. *J. Indian Soc. Agric. Statist.* (1952), **4**, 42–49. 9¾″.

Swerling (Boris C.). A sugar policy for the United States. *Amer. Econ. Rev.* (1952), **42**, 347–357. 9¼″.

United States commodity imports in the longer run. *Econ. J.* (1952), **62**, 35–41. 9¾″.

Thompson (Alexander John). Logarithmetica britannica: being a standard table of logarithms to twenty decimal places ... Part II (the ninth and final part to be published). Numbers 20,000 to 30,000; together with general introduction ... C.U.P., 1952. [216] pp. various paging. phot. 11″. 45*s.* (Tracts for Computers, 22.)

Thompson (J. Walter) Company, *compiler.* Population and its distribution. 7th ed. 1951. New York & London, McGraw-Hill, [1952]. xvii, 428 pp. map. 11″. 127*s.* 6*d.*

Timber Development Association. T.D.A. statistical year book 1951. London, 1952. 24 pp. 10″.

Tinbergen (Jan). Einführung in die Ökonometrie. Wien-Stuttgart, Humboldt, [1952]. 271 pp. 7″.

On the theory of economic policy. Amsterdam, North-Holland Publishing Co., 1952. 4 p.l., 78 pp. 8½″. 13*s.* (Contributions to Economic Analysis, 1.)

Vinci (Felice). Felice Vinci. Reddito collettivo e piano d'investimenti.—Felice Vinci. Chiarimenti sulle produzioni e gli appagamenti comuni.—Federico Gualtierotti. I sindacati dei lavoratori e l'ordinamento capitalistico. Milano, 1951. 55 pp. 9½″. L.400. (Università degli Studi di Milano, Istituto di Scienze Economiche e Statistiche, Quaderni 14.)

Wagemann (Ernst). Narrenspiegel der Statistik: die Umrisse eines statistischen Weltbildes. 3. Aufl. Bern, A. Francke, [1950]. 252, [1] pp. 8¾″. 21*s.* 6*d.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Westoff (Charles F.) & Kiser (Clyde V.). The interrelation of fertility, fertility planning, and feeling of personal inadequacy. *Milbank Mem. Fd. Quart. Bull.* (1952), **30**, 239–297. 9″.

Whelpton (P. K.) & Kiser (Clyde V.), *editors.* Social and psychological factors affecting fertility. Vol. three: further reports on hypothesis in the Indianapolis study. *Milbank Mem. Fd. Quart. Bull.* (1951–1952), **29–30**, vi, 467–799. 9″.

Wilcocks (W. J.) & Lancaster (H. O.). Maternal mortality in New South Wales with special reference to age and parity. *J. Obstet. Gynaec., Brit. Emp.* (1951), **58**, 945–960. 9¾″.

Williams (C. B.). Sequences of wet and of dry days considered in relation to the logarithmic series. *Q. J. R. Met. Soc.* (1952), **78**, 91–96. 10″.

Williams (E. J.). Applications of component analysis to the study of properties of timber. *Aust. J. Appl. Sci.* (1952), **3**, 101–118. 9¾″

Wishart (John). Biological experimentation. *Incorporated Statistician* (1951), **2**. 9 pp. 8½″.

The combinatorial development of the cumulants of the *k*-statistics. *Trabajos de Estadistica* (1952), **3**, 13–26. 9½″.

Yates (F.). The influence of *statistical methods for research workers* on the development of the science of statistics. *J. Amer. Statist. Ass.* (1951), **46**, 19–34. 9¼″.

Recent applications of biometrical methods in genetics. (1) Experimental techniques in plant improvement. *Biometrics* (1950), **6**, 200–207. 9″.

Yoshihara (Tomokichi). On the fitting, the summation, and an application of the logistic curve. *J. Tokyo Univ. Fish.* (1951), **38**, 181–195. 10″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVENUE OF THE UNITED KINGDOM

Net Produce in Quarters of 1952, *and the Financial Years ended March* 31, 1951–52, 1950–51, 1949–50, 1948–49

(000's omitted)

QUARTERS ended	March 31 1952	June 30, 1952	Sept. 30, 1952	Dec. 31, 1952	Total for Calendar Year 1952
	£	£	£	£	£
Inland Revenue—					
Income Tax	1,019,106	260,317	213,785	181,748	1,674,956
Surtax	76,600	21,500	12,100	17,400	127,600
Death duties	43,700	39,100	34,200	37,850	154,850
Stamps	14,900	12,750	11,700	12,800	52,150
Profits tax and excess profits tax	73,500	63,700	129,700	101,700	368,600
Excess profits levy	—	—	—	100	100
Special contribution and other Inland Revenue duties	990	540	410	360	2,300
Total Inland Revenue	1,228,796	397,907	401,895	351,958	2,380,556
Customs	244,647	251,033	262,955	260,154	1,018,789
Excise	184,685	179,812	179,826	189,463	733,786
Total Customs and Excise	429,332	430,845	442,781	449,617	1,752,575
Motor vehicle duties	49,090	6,374	5,389	4,432	65,285
Surplus receipts from certain trading services	1,000	..	..	..	1,000
Post Office (net receipts)	..	..	..	1,700	1,700
Broadcast receiving licences	4,950	2,700	2,350	4,550	14,550
Receipts from sundry loans	4,889	2,824	15,934	1,291	24,938
Miscellaneous receipts (including sale of surplus war stores)	33,108	30,766	16,802	43,625	124,301
Total Ordinary Revenue	1,751,165	871,416	885,151	857,173	4,364,905
Self-balancing Revenue—					
Post Office	48,550	44,200	48,800	55,200	196,750
Income tax deducted from excess profits tax, post-war refunds	1,367	1,275	938	1,301	4,881

YEARS ended March 31	1951–52	1950–51	1951–52 (compared with 1950–51)		Corresponding Years	
			Increase	Decrease	1949–50	1948–49
Inland Revenue—						
Income tax	1,668,749	1,404,364	264,385	..	1,438,386	1,367,570
Surtax	129,600	121,100	8,500	..	114,700	97,900
Death duties	183,000	185,250	..	2,250	189,600	177,141
Stamps	61,900	54,460	7,440	..	51,470	56,433
Profits tax and excess profits tax	315,400	267,770	47,630	..	296,960	278,895
Other Inland Revenue duties	600	595	5	..	638	700
Special contribution	2,670	4,850	..	2,180	19,600	79,450
Total Inland Revenue	2,361,919	2,038,389	327,960	4,430	2,111,354	2,058,089
Customs	998,497	905,216	93,281	..	813,334	823,258
Excise	753,285	724,800	28,485	..	706,400	733,500
Total Customs and Excise	1,751,782	1,630,016	121,766	..	1,519,734	1,556,758
Motor vehicle duties	65,211	61,357	3,854	..	55,772	52,716
Sale of surplus war stores	32,345	45,355	..	13,010	79,138	99,597
Surplus receipts from certain trading services	75,455	80,905	..	5,450	47,541	28,564
Post Office (net receipts)	..	962	..	962	..	..
Broadcast receiving licences	14,150	13,000	1,150	..	12,600	11,700
Receipts from sundry loans	25,393	26,876	..	1,483	20,244	17,683
Miscellaneous receipts (including Crown lands)	107,137	80,964	26,173	..	77,648	181,483
Total Ordinary Revenue	4,433,392	3,977,824	480,903	25,335	3,924,031	4,006,590
Self-balancing Revenue—						
Post Office	190,050	171,088	18,962	..	162,100	152,700
Income tax deducted from excess profits tax, post-war refunds	5,525	8,347	..	2,822	11,893	8,751

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

BANK OF ENGLAND

Pursuant to the Act 7th and 8th Victoria, cap. 32 (1844)

(000's omitted)

1	2	3	4	5	6	7	8
		Issue Department				Collateral Columns	
Liabilities	Dates (Wednesdays)	Assets					
Notes Issued		Govt. Debt (£11,015) and Govt. Securities	Other Securities	Gold Coin and Bullion*	Silver Coin†	Notes in Hands of Public	Minimum Discount Rate
£		£	£	£	£	£	
1,450,357	Jan. 2	1,446,735	752	357	2,513	1,419,026	2½%
1,450,357	,, 9	1,446,716	772	357	2,512	1,395,786	
1,400,357	,, 16	1,396,833	654	357	2,513	1,367,271	
1,400,357	,, 23	1,396,759	728	357	2,513	1,353,622	
1,400,357	,, 30	1,396,784	705	357	2,511	1,358,824	
1,400,357	Feb. 6	1,396,783	704	357	2,513	1,357,649	
1,400,357	,, 13	1,396,754	732	357	2,514	1,360,636	
1,400,357	,, 20	1,396,689	798	357	2,513	1,360,582	
1,400,357	,, 27	1,396,770	715	357	2,515	1,367,027	
1,400,357	Mar. 5	1,396,796	690	357	2,514	1,375,141	4%
1,400,357	,, 12	1,396,760	727	357	2,513	1,380,230	
1,400,357	,, 19	1,396,818	671	357	2,511	1,381,558	
1,400,357	,, 26	1,396,740	745	357	2,515	1,384,560	
1,450,357	Apr. 2	1,446,727	761	357	2,512	1,393,955	
1,450,357	,, 9	1,446,717	771	357	2,512	1,413,651	
1,450,357	,, 16	1,446,739	746	357	2,515	1,418,809	
1,450,357	,, 23	1,446,716	773	357	2,511	1,411,825	
1,450,357	,, 30	1,446,724	766	357	2,510	1,409,981	
1,450,357	May 7	1,446,822	666	357	2,512	1,409,445	
1,450,357	,, 14	1,446,744	746	357	2,510	1,409,167	
1,450,357	,, 21	1,446,728	758	357	2,514	1,405,923	
1,450,357	,, 28	1,446,768	718	357	2,514	1,412,174	
1,450,357	June 4	1,446,742	748	357	2,510	1,420,092	
1,450,357	,, 11	1,446,720	766	357	2,514	1,425,619	
1,450,357	,, 18	1,446,789	701	357	2,510	1,431,095	
1,500,357	,, 25	1,496,738	751	357	2,511	1,442,076	
1,500,357	July 2	1,496,777	710	357	2,513	1,451,816	
1,500,357	,, 9	1,496,789	697	357	2,514	1,465,381	
1,500,357	,, 16	1,496,750	735	357	2,515	1,484,795	
1,550,357	,, 23	1,546,832	655	357	2,513	1,502,632	
1,550,357	,, 30	1,546,771	718	357	2,511	1,515,099	
1,550,357	Aug. 6	1,546,825	660	357	2,515	1,508,369	
1,550,357	,, 13	1,546,808	679	357	2,513	1,493,124	
1,550,357	,, 20	1,546,768	720	357	2,512	1,470,886	
1,500,357	,, 27	1,496,796	690	357	2,514	1,458,955	
1,500,357	Sept. 3	1,496,787	701	357	2,512	1,455,459	
1,500,357	,, 10	1,496,765	723	357	2,512	1,451,995	
1,500,357	,, 17	1,496,731	746	357	2,513	1,446,805	
1,500,357	,, 24	1,496,765	722	357	2,513	1,444,102	
1,500,357	Oct. 1	1,496,802	684	357	2,514	1,445,746	
1,500,357	,, 8	1,496,741	748	357	2,511	1,446,522	
1,500,357	,, 15	1,496,757	732	357	2,511	1,44,5363	
1,500,357	,, 22	1,496,799	687	357	2,514	1,443,487	
1,500,357	,, 29	1,496,722	764	357	2,513	1,444,215	
1,500,357	Nov. 5	1,496,781	704	357	2,515	1,449,474	
1,500,357	,, 12	1,496,764	722	357	2,514	1,452,234	
1,500,357	,, 19	1,496,722	766	357	2,512	1,455,462	
1,500,357	,, 26	1,496,782	706	357	2,512	1,461,428	
1,500,357	Dec. 3	1,496,763	722	357	2,515	1,481,557	
1,550,357	,, 10	1,546,735	751	357	2,514	1,512,709	
1,550,357	,, 17	1,546,755	732	357	2,512	1,539,247	
1,575,357	,, 24	1,571,768	718	357	2,514	1,550,357	
1,575,357	,, 31	1,571,769	717	357	2,514	1,525,462	

* At 248*s.* 0*d.* per fine oz.

† Coin other than Gold Coin.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

WEEKLY RETURN

for Wednesday in each Week, during the year 1952

(000's omitted)

9	10	11	12	13	14	15	16	17	18
BANKING DEPARTMENT									
Liabilities				DATES (Wednesdays)	Assets				Totals of Liabilities and Assets
Capital (£14,553) and Rest	Public Deposits‡	Bankers' Deposits	Other Deposits		Govt. Securities	Discounts and Advances	Other Securities	Reserve (Notes and Coin)	
£	£	£	£		£	£	£	£	£
18,153	14,804	304,943	92,226	Jan. 2	348,678	22,928	25,529	32,991	430,126
18,192	18,584	304,296	91,860	,, 9	339,028	14,218	23,421	56,265	432,932
18,230	13,519	297,687	86,163	,, 16	345,548	12,580	22,687	34,784	415,599
18,327	15,206	287,597	85,097	,, 23	297,413	37,415	23,082	48,317	406,227
18,333	16,035	277,785	87,496	,, 30	309,253	7,861	34,414	48,121	399,649
18,350	27,812	286,616	85,737	Feb. 6	327,213	4,365	42,659	44,278	418,515
18,353	30,198	280,742	83,840	,, 13	327,743	16,095	28,017	41,278	413,133
18,416	11,861	292,372	83,113	,, 20	319,013	17,559	27,850	41,340	405,762
18,454	12,226	282,989	83,057	,, 27	311,828	17,653	32,341	34,904	396,726
18,467	20,195	274,205	83,716	Mar. 5	334,538	9,473	25,795	26,777	396,583
18,475	15,281	286,092	85,505	,, 12	343,113	15,650	24,915	21,675	405,353
18,500	11,759	287,371	82,141	,, 19	338,138	16,114	25,181	20,338	399,771
18,531	12,659	280,263	81,254	,, 26	325,918	23,562	25,857	17,370	392,707
18,549	11,341	282,202	82,377	Apr. 2	282,946	29,437	24,125	57,961	394,469
17,716	14,741	277,106	79,651	,, 9	310,672	19,086	21,212	38,244	389,214
17,748	10,870	284,342	77,288	,, 16	312,181	25,635	19,397	33,035	390,248
17,786	11,279	286,059	76,846	,, 23	308,652	21,925	21,385	40,008	391,970
17,825	11,222	272,950	73,417	,, 30	274,341	27,430	31,769	41,874	375,414
17,868	10,588	266,393	72,984	May 7	273,352	14,120	37,982	42,379	367,833
17,899	12,175	269,808	71,281	,, 14	286,331	15,800	26,355	42,677	371,163
17,901	11,343	281,659	71,863	,, 21	295,047	17,300	24,490	45,929	382,766
17,973	10,611	270,020	72,634	,, 28	288,116	11,927	31,508	39,687	371,238
18,013	12,925	258,504	69,991	June 4	296,191	12,597	18,883	31,762	359,433
18,028	31,327	290,972	68,841	,, 11	342,127	20,907	19,886	26,248	409,168
18,089	24,011	287,392	70,233	,, 18	347,171	12,202	19,605	20,747	399,725
18,140	24,227	275,675	72,519	,, 25	289,947	21,172	19,664	59,778	390,561
18,158	30,508	274,966	70,769	July 2	280,541	45,997	17,844	50,019	394,401
18,176	27,795	283,219	69,826	,, 9	316,116	28,667	17,783	36,450	399,016
18,234	28,021	272,908	64,727	,, 16	324,226	25,307	17,309	17,048	383,890
18,293	28,484	265,238	65,669	,, 23	282,872	28,347	17,237	49,228	377,684
18,305	28,621	262,007	69,213	,, 30	292,331	21,647	27,390	36,778	378,146
18,375	33,990	258,521	66,580	Aug. 6	285,797	17,635	30,517	43,517	377,466
18,387	12,925	262,507	65,006	,, 13	264,986	11,796	23,264	58,779	358,825
18,412	28,305	268,428	66,484	,, 20	268,526	12,880	19,191	81,032	381,629
18,448	38,963	252,369	64,844	,, 27	296,936	7,240	27,476	42,972	374,624
18,479	33,700	257,686	67,195	Sept. 3	301,255	12,660	16,665	46,480	377,060
18,488	45,567	265,979	65,862	,, 10	324,160	5,785	16,017	49,934	395,896
18,506	43,041	276,938	65,306	,, 17	317,715	14,975	15,966	55,135	403,791
18,528	35,324	275,654	67,028	,, 24	317,785	5,215	15,685	57,849	396,534
18,550	42,473	260,972	66,797	Oct. 1	303,055	5,949	23,578	56,210	388,792
17,704	37,487	275,239	64,346	,, 8	317,225	8,385	13,717	55,449	394,776
17,721	34,765	277,815	65,201	,, 15	318,660	6,205	14,013	56,624	395,502
17,775	34,107	278,084	64,493	,, 22	315,225	6,465	14,285	58,484	394,459
17,815	35,733	271,552	66,737	,, 29	299,445	9,295	25,355	57,742	391,837
17,847	39,486	272,427	67,553	Nov. 5	306,955	7,495	30,390	52,473	397,313
17,883	39,259	283,049	67,946	,, 12	333,680	5,030	19,727	49,700	408,137
17,953	39,749	279,983	71,711	,, 19	332,305	12,255	18,377	46,459	409,396
17,962	41,976	275,378	72,637	,, 26	341,850	9,860	15,773	40,470	407,953
17,994	35,938	275,022	70,500	Dec. 3	354,430	10,645	14,063	20,316	399,454
18,029	30,768	273,761	71,158	,, 10	332,365	8,645	13,564	39,142	393,716
18,075	34,991	275,381	73,264	,, 17	368,255	7,445	13,429	12,582	401,711
18,097	45,454	269,628	74,022	,, 24	359,200	9,897	11,671	26,433	407,200
18,147	34,242	302,848	78,526	,, 31	355,515	11,232	15,699	51,317	433,763

‡ Including Exchequer, Savings Banks, Commissioners of Nat. Debt., and Div. Accounts and H.M. Treasury Special Account.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of the Royal Statistical Society
SERIES A (GENERAL)
PART II, 1953

Regional Variations in United Kingdom Incomes from Employment, 1948

By Phyllis Deane

University of Cambridge, Department of Applied Economics

[Read before the Royal Statistical Society, January 28th, 1953, Professor A. Bradford Hill, C.B.E., Ex-President, in the Chair]

I. Introduction

As part of an inquiry now in progress at the University of Cambridge Department of Applied Economics into the regional social accounts of the United Kingdom, an attempt has been made to calculate the distribution by regions of the 1948 wage and salary bill. This is a preliminary report on the results so far achieved in this direction, and although most of these are subject to revision as new data are published (more particularly the Final Reports on the 1948 Census of Production), it was thought that even in this preliminary form they reflect the broad pattern of regional variations in earnings from employment.

The regions which have been adopted as a starting-point are the standard administrative regions of the United Kingdom. Their significance for purposes of economic analysis is reduced by their largeness, and by the fact that their boundaries are not dictated primarily by economic considerations. Since they are now the standard divisions for most official regional statistics, and in particular for the Ministry of Labour employment and earnings inquiry data, it is convenient, however, to use them as a starting-point. How far it may be possible to subdivide them into more significantly "economic" regions is a problem which will be considered among the broader aspects of the regional social accounting inquiry.

The method adopted for most industries has been to estimate a national average of annual earnings, and an index of regional variations, and to apply these estimates to the published employment figures after adjusting these as nearly as we could to an average for the year. Most of the original calculations from which the estimates given in this paper are derived were made by Mrs. Rose Knight in 1950. Mrs. Knight's estimates have, however, been revised throughout in the light of data published since she completed them—in particular, the revised regional employment figures published in 1951 and the full preliminary results of the 1948 Census of Production also published in 1951.* More complete revision will be undertaken when the full summary results of the 1948 Census are available by regions, and when research now in progress into other aspects of the regional social accounts is complete. Because of their interim nature the estimates given in this paper and the conclusions which have been drawn from them are broad and tentative. In the following Section (II) a general description is given of the methods used in estimating the numbers employed and the aggregate annual earnings in each region. A more detailed description, industry by industry, is given in a mimeographed Appendix.† In Section III the broad regional variations in average annual earnings per head are examined.

* In most cases these amendments and revisions made in the light of more recent information were incorporated into a structure already built up in the original calculations. To Mrs. Knight must go most of the credit for the results shown in Table 1, which is largely a summary, after revision, of the detailed estimates prepared by her in 1950.

† A limited number of copies are available on application to the Secretary of the Society.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

II. METHODS OF ESTIMATION

Estimates of the wage and salary bill were built up from (*a*) numbers employed and (*b*) average earnings for each region for as detailed an industrial division as possible.

(a) *Numbers Employed*

The basis of our employment estimates was the numbers of insured employed at the end of June, 1948, as published by the Ministry of Labour (1951). The Northern Ireland Ministry of Labour and National Insurance kindly supplied corresponding figures of insured employed for that region.

In applying these figures to averages derived from Census of Production sources it was necessary to make allowance for some differences in definition. The Ministry of Labour figures cover all workers in employment in a given week including those absent for trade disputes or temporarily stood off. The Census reports give figures which are closer to an annual average, since the returns cover workers employed during specified weeks throughout the year: on the other hand, they do not cover temporarily unemployed workers stood off a full week or absent for a full week on account of a trade dispute.

It was possible to adjust Ministry of Labour figures to a yearly average for most industries by using tables published each month in the *Ministry of Labour Gazette* (e.g., Ministry of Labour, 1948). These numbers, although recorded on the old basis of numbers insured (i.e., before the National Insurance Act 1946 took effect), were used as a monthly index of employment for the year 1948. For most industries the difference between the June figure and the annual average is slight, varying from -1 per cent. to $+1{\cdot}6$ per cent.* Unfortunately, however, some activities where seasonal fluctuations are of great importance are not included in these monthly employment estimates, e.g., agriculture, fishing and forestry, and we have to estimate annual averages on the basis of unemployment figures and other relevant sources.

In principle it would be possible further to adjust the Ministry of Labour employment figures so that they correspond to the Census definition by allowing for workers who were stood-off or who were on strike for the whole of a week. It was not possible to do so on the basis of the published information, however, and in view of the fact that the estimates will be more thoroughly revised when the full regional results of the 1948 Census become available, we did not seek the unpublished data necessary to refine the employment figures.

(b) *Average Annual Earnings*

For industries covered by the 1948 Census of Production it was possible to use the Preliminary Reports of the Census to find a national average (Board of Trade, 1951). The Final Reports, which are still in process of publication, contain regional analyses of wage and salary data for the individual industries except where this would infringe the disclosure provisions of the Census. In practice this has meant that the full regional analysis is available for only a minority of industries, and estimates of regional variations on the basis of Census results must await the publication of regional summary tables.

For the estimates in this paper the Ministry of Labour kindly supplied us with regional tables of their Earnings Inquiry of October, 1949, and from these we were able to compute a regional index of earnings for each industry covered by the inquiry. The fine industrial breakdown gave rather small samples in some regions, and firms which made returns covering several regions were omitted from the regional tables. Consequently the sum of the products of numbers and earnings in each region did not give exactly the same total as the aggregate earnings derived from total numbers and average earnings for the country as a whole. As the United Kingdom average is likely to be more nearly correct than are the regional ones we used a correction factor to scale the latter up or down as required. The relationship between regions was not thereby altered, since the same correction was applied for each industry to all regions. The magnitude of the correction factor was in nearly all cases below 5 per cent. and in large industries it was usually $\frac{1}{2}$ to 1 per cent.

* One exception is catering, with an average of 3 per cent. below the June employment figure.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The regional earnings cover wage-earners only, but in most cases the index was applied also to salaried staff. In some industries, however, we used a regional index for salaried staff which was based on regional variations in clerical workers' salaries. This we computed from average earnings by region as shown by the 1950 inquiry of the Office Management Association (1950).* Unfortunately these results cover a particular kind of salaried worker only, and since they relate mainly to members of the Office Management Association who have introduced its job-grading system, the numbers are not drawn from each region (or from each industry) proportionately to the numbers of clerical workers employed there. We did not attempt to use the industrial breakdown for each region, on the assumption that industrial differences within regions were not significant for clerical workers.

One other source which provided the starting-point for a number of estimates was the table of earnings assessed for P.A.Y.E. purposes, classified by industry, which was published in the 1948–49 report of the Commissioners of Inland Revenue (Board of Inland Revenue, 1950, Table 83). This related to incomes earned in 1948–9 rather than 1948 (although the difference, judging by the wage and salary estimates in the National Income White Paper, did not exceed 2 per cent.); it excludes incomes in kind, and it excludes incomes below the P.A.Y.E. deduction limit; its value may also be reduced for some industries (particularly those for which part-time or seasonal employment is important) by incomplete returns—due amongst other causes to attempts at tax evasion. For all these reasons the P.A.Y.E. returns constitute a less satisfactory basis from which to estimate national average or national aggregate earnings than either the Census of Production or the Ministry of Labour Earnings Inquiry results, but for those industries where neither the Census or Earnings Inquiry results nor any other direct source of evidence are applicable (e.g., wholesale distribution, finance or fishing) they provide a useful starting-point.

Of the other sources utilized for particular industries, some (e.g., the reports of the Coal Board and the Electricity Board) were more satisfactory than the available Census or Earnings Inquiry data: some, while being more reliable in principle (e.g., the reports of the British Transport Commission or the Civil Appropriation Accounts), were unsatisfactory in that they did not give the information in the form required or covered an insufficient part of the relevant field (e.g., the costing statistics of the Ministry of Education, which cover only those primary and secondary schools which are wholly maintained by local education authorities).

Table I sets out the estimates by region and by industrial order. The appendix to this paper gives further details of estimates for the individual industries. No attempt has been made at this stage in the inquiry to assess quantitative margins of error for the regional results. For the convenience of those who are interested in the details of Table I, however, some qualitative comments on the reliability of the results may be useful.

Our best estimates were for the industries covered by the Census of Production. For these (Orders II–XVIII) we had Census of Production results to give national averages and Earnings Inquiry or other reliable data (e.g., National Coal Board Accounts for coal-mining) to give regional variations. These industries, which cover rather more than half the insured population, are also those for which we expect to arrive at more reliable results when the full regional results of the 1948 Census are available. At that stage we shall be able to discard our untested assumption that the 1949 pattern of regional variations did not differ greatly from the 1948 patterns. If we were to adopt a rough grading of estimates—A = fairly reliable, B = rough, C = conjectural—we should put this group into the A category, and hope to grade it "reliable" as a result of future revisions.

Our least satisfactory estimates were for (*a*) Insurance, Banking and Finance, where our estimate of national average was based on P.A.Y.E. assessments and where we had no regional information, and for (*b*) Miscellaneous Services, where the basic information came from a variety of sources, most of which were not readily adaptable to our purpose. The estimates for Agriculture and Forestry were also unsatisfactory, but we hope to achieve more reliable results as a by-product of an investigation into the regional distribution of the net output of agriculture which is part of the programme of the regional social accounting inquiry mentioned above. In terms of the rough grading suggested in the previous paragraph these industries would fall into the C

* The original data were kindly supplied by the Office Management Association from working sheets of their 1950 inquiry.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 1

Estimated Average Numbers Employed, Average Annual Earnings and Aggregate Earnings in 1948 by Region of the United Kingdom

			United Kingdom	Northern	E. and W. Ridings	North Midland	Eastern	London and South-east	Southern	South-western	Wales	Midland	North-western	Scotland	Northern Ireland
I	*Agriculture, forestry, fishing*														
	(*a*) Number of employees	(000)	966·7	46·9	44·4	103·8	156·3	120·0	68·1	90·2	42·7	68·5	46·3	127·6	52·0
	(*b*) Average annual earnings	(£)	279	251	283	307	311	303	250	260	222	288	349	255	202
	(*c*) Aggregate annual earnings	(£ mill.)	270·2	11·8	12·6	31·9	48·6	36·4	17·0	23·5	9·5	19·7	16·2	32·6	10·5
II	*Mining and Quarrying*														
	(*a*) Number of employees	(000)	876·7	181·4	151·8	122·4	2·5	13·2	2·0	21·0	140·8	71·6	67·6	98·5	3·9
	(*b*) Average annual earnings	(£)	385	403	384	409	335	404	333	349	366	373	365	392	253
	(*c*) Aggregate annual earnings	(£ mill.)	338·0	73·1	58·3	50·0	0·8	5·3	0·7	7·3	51·6	26·7	24·7	38·6	1·0
III–XVI	*Manufacture*														
	(*a*) Number of employees	(000)	8,098·4	397·5	826·9	581·9	337·0	1,701·4	268·3	317·0	243·0	1,067·0	1,402·3	756·0	200·2
	(*b*) Average annual earnings	(£)	310	308	296	305	320	336	325	302	321	326	296	289	238
	(*c*) Aggregate annual earnings	(£ mill.)	2,514·4	122·4	244·6	177·4	107·9	571·0	87·1	95·9	77·9	348·2	415·8	218·6	47·7
XVII	*Building and contracting*														
	(*a*) Number of employees	(000)	1,323·7	74·6	91·0	81·0	83·2	350·7	77·0	83·8	59·8	99·1	147·3	146·7	29·5
	(*b*) Average annual earnings	(£)	317	298	313	329	310	339	295	291	305	310	314	320	260
	(*c*) Aggregate annual earnings	(£ mill.)	419·1	22·2	28·5	26·7	25·8	118·8	26·7	24·4	18·2	30·7	46·3	47·0	7·7
XVIII	*Gas, electricity and water*														
	(*a*) Number of employees	(000)	318·3	15·3	23·4	17·1	17·7	97·8	17·2	19·2	13·1	27·0	41·3	23·8	5·4
	(*b*) Average annual earnings	(£)	344	333	330	326	334	381	320	318	320	339	329	323	309
	(*c*) Aggregate annual earnings	(£ mill.)	109·5	5·1	7·7	5·6	5·9	37·2	5·5	6·1	4·2	9·2	13·6	7·7	1·7
XIX	*Transport and communication*														
	(*a*) Number of employees	(000)	1,778·0	102·8	137·5	92·8	64·7	501·9	81·6	98·3	90·0	114·2	272·6	191·7	29·8
	(*b*) Average annual earnings	(£)	370	367	356	359	365	386	379	360	363	363	369	356	348
	(*c*) Aggregate annual earnings	(£ mill.)	657·3	37·8	48·9	33·3	23·6	193·9	30·9	35·4	32·7	41·4	100·6	68·3	10·4
XX	*Distributive trades*														
	(*a*) Number of employees	(000)	2,077·2	110·4	160·9	116·5	102·8	593·6	97·6	112·4	80·7	151·0	273·4	229·9	48·1
	(*b*) Average annual earnings	(£)	278	247	280	279	272	298	264	265	257	282	285	256	244
	(*c*) Aggregate annual earnings	(£ mill.)	577·0	27·2	45·0	32·5	28·0	176·9	25·8	29·8	20·7	42·6	77·9	58·9	11·7
XXI	*Insurance, banking and finance*														
	(*a*) Number of employees	(000)	431·6	14·3	20·5	11·3	12·2	232·7	12·6	11·5	10·2	19·9	49·5	31·1	5·8
	(*b*) Average annual earnings	(£)	457	421	421	421	421	488	421	421	421	421	421	421	421
	(*c*) Aggregate annual earnings	(£ mill.)	197·4	6·0	8·6	4·8	5·1	113·7	5·3	4·9	4·3	8·4	20·8	13·1	2·4
XXII	*Public Administration*														
	(*a*) Number of employees	(000)	1,463·0	74·6	91·9	85·4	71·6	448·9	97·6	94·8	69·9	107·0	168·3	122·2	30·9
	(*b*) Average annual earnings	(£)	348	320	320	318	309	401	341	320	310	334	333	330	303
	(*c*) Aggregate annual earnings	(£ mill.)	509·2	23·9	29·4	27·1	22·1	179·8	33·3	30·4	21·7	35·7	56·1	40·3	9·4
XXIII	*Professional Services*														
	(*a*) Number of employees	(000)	1,320·9	67·4	94·4	68·4	79·5	379·8	72·2	77·2	57·9	101·7	157·0	144·4	21·0
	(*b*) Average annual earnings	(£)	345	345	338	332	335	364	338	329	344	329	335	348	300
	(*c*) Aggregate annual earnings	(£ mill.)	455·3	23·2	31·9	22·7	26·6	138·4	24·4	25·4	19·9	33·4	52·6	50·3	6·3
XXIV	*Miscellaneous services*														
	(*a*) Number of employees	(000)	1,805·8	95·9	114·9	80·0	103·3	569·2	129·2	119·4	70·3	117·0	207·0	160·7	38·9
	(*b*) Average annual earnings	(£)	223	215	221	214	210	240	203	209	211	221	231	212	186
	(*c*) Aggregate annual earnings	(£ mill.)	402·4	20·6	25·4	17·1	21·7	136·5	26·3	24·9	14·8	25·8	47·8	34·1	7·3
TOTAL ALL INDUSTRIES															
	(*a*) Number of employees	(000)	20,460·3	1,181·1	1,737·5	1,369·5	1,030·8	5,009·3	923·3	1,044·8	878·2	1,944·2	2,832·5	2,032·6	465·5

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

category, but we should expect to up-grade agriculture, etc., to the B category when our further investigations are complete.*

For the remaining industries—transport, distribution, public administration and professional services the information was patchy. Broadly grouped as they are we would grade them in the B category as "rough estimates", but they are built up from a large number of individual estimates, some of which we would put into the A or the C categories. Some of them we expect to improve upon considerably as a result of our own further investigations (e.g., into the local authority sector), and some will be improved upon when the available statistical resources are improved.

In assessing broadly the reliability of the estimates in Table 1 it is relevant to take into account the corresponding estimates for the United Kingdom which were published recently in the Blue Book on National Income and Expenditure (Central Statistical Office, 1951). The Blue Book total for all industries is 3½ per cent. less than our total, a discrepancy which is within the margin of error of our estimate. Apart from differences (which must be primarily due to differences of classification) in building and contracting and gas, electricity and water, significant differences arise for (*a*) agriculture, forestry and fishing, (*b*) transport and communication, and (*c*) the broad group of professional, administrative, financial and other services. These are all industries where special sources of income (income in kind, tips, superannuation contributions, etc.) are considerable, and liable to lead to important differences of definition, as well as of estimate, between different investigators: we have allowed as fully as we could for all these additional incomes, and think it probable that we have included a wider range of them in our estimates. There remain discrepancies between the estimates for agriculture, forestry and fishing and for transport and communication which we do not think can be entirely attributed to differences of classification or definition, and which we would attribute to underestimates in the Blue Book figures. These are not instances in which we are at all content with our own estimates, however, and the possibility that there are overestimates in our results for those two industry groups should equally be borne in mind.†

III. *The Regional Variations*

1. *The Regions*

The twelve Standard Regions of the United Kingdom which we have taken as the basis of our regional breakdown include the three countries of Scotland, Northern Ireland and Wales and nine divisions of England. These are not particularly satisfactory regions for purposes of economic analysis. They are generally too large to be very specialized; they are in no way self-contained; and their boundaries have been inspired by administrative rather than by economic considerations.

Their lack of uniqueness makes the regional pattern a difficult one to describe briefly. Northern Ireland is the most specialized of all the regions, the smallest in terms of population, and the most self-contained. It has about 23 per cent. of its insured population engaged in textile or clothing manufacture, and if we consider the working population as a whole, an even larger proportion of persons was engaged in agriculture.‡ Scotland is the largest in terms of area (though not of population) and differs least of all the regions from the United Kingdom pattern of industrial structure. London and the South-east accounts for more than 20 per cent. of the population of the United Kingdom, and wide though its bounds are set, it still dominates the adjacent areas of Eastern and Southern regions, giving them an inflated share in the urban service industries (building, contracting, gas, electricity and water). The central regions of England (Midlands, North-west, North Midlands and East and West Ridings) are the primary manufacturing regions, but

* Research into the regional net output of agriculture and also into the regional social accounts of the local authorities of the United Kingdom is being currently pursued at the Department of Applied Economics by Mr. E. B. Butler. The estimates for wages and salaries earned in fishing, which have been incorporated into item 1 of Table 1 were made by Mr. Butler in the course of an investigation into the regional net output of the fishing industry. We are indebted to the Scottish Department of Agriculture and to Mr. Norman Cuthbert of Queen's University, Belfast, for the information on which we based our estimates of the agricultural wage-bill in Scotland and Northern Ireland respectively.

† See the Appendix to this paper (Section 10) for a more specific comparison of our industry totals with the Blue Book totals.

‡ Many of these are "members of family" who do not figure among the insured employed.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

even Eastern region—the chief agricultural region of Great Britain—has about a third of its insured population engaged in manufacture. The chief mining regions are Northern region and Wales, both of which combine a relatively high proportion of mining employment with some specialization in heavy engineering. The least specialized region of England is South-western. Probably the least economically self-contained region is Wales, whose northern counties have stronger links with North-western region than with the southern counties of Wales; but the agricultural and fishing areas in the east of England stretch uninterruptedly across three regional boundaries, and it would also be difficult to justify from an economic standpoint the regional boundaries which cut through the conglomeration of industrial and mining areas in the centre of England.

All this makes it difficult not only to describe the regional economic pattern in broad and simple terms, but even to define it adequately in detail for practical purposes. Since our starting-point is the Ministry of Labour regional analysis of insured employees, the region to which a worker is assigned depends on the location of the Ministry of Labour branch at which he is registered. This may differ in practice from the region in which he lives or from the region in which he works; it may even differ from either. The mobility of labour across London's borders is well known,

TABLE 2

Distribution of the Insured Population within Each Region, 1948

	United Kingdom	*Northern*	*E. and W. Ridings*	*North Midland*	*Eastern*	*London and South-east*	*Southern*	*South-western*	*Wales*	*Midland*	*North-western*	*Scotland*	*Northern Ireland*
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%
1. Agriculture, forestry and fishing	4·5	4·0	2·5	7·6	15·2	2·4	7·4	8·6	4·8	3·5	1·6	6·2	5
2. Mining and quarrying	4·3	15·4	8·7	9·0	0·3	0·3	0·2	2·0	16·0	3·7	2·4	4·9	1
3. Manufacture	39·6	33·5	46·9	42·6	32·5	33·8	28·9	30·1	27·5	54·7	49·3	37·0	45
4. Building, contracting, gas, electricity and water	8·2	7·7	6·6	7·3	9·8	9·0	10·2	9·9	8·3	6·5	6·7	8·5	7
5. Transport and distribution	19·5	18·0	17·0	15·4	16·2	21·9	19·4	20·2	19·5	13·7	19·3	20·8	17
6. Finance, public administration, professional services	14·9	13·2	11·8	12·2	15·8	21·2	19·7	17·5	15·7	11·8	13·2	14·7	13
7. Miscellaneous	9·0	8·3	6·7	6·0	10·2	11·6	14·2	11·6	8·1	6·1	7·5	8·1	8

and although we have avoided some of the complexities by including the south-eastern counties in the London area, the dormitory area for London spreads even beyond these wide borders. Nor are the problems confined to situations where large commercial or industrial centres exert a magnetic pull beyond their regional boundaries. When the regional boundary runs through an industrial or mining area it may be extremely difficult to apply a consistent definition to existing records. If, for example, we estimate regional employment in coal-mining from data in the National Coal Board Accounts, as we can reasonably expect to be able to do, and try to reconcile these results with the Ministry of Labour figures, we find differences which can only be explained on the assumption that a large group of workers which the Ministry of Labour attributes to East and West Ridings figure in National Coal Board Accounts in areas of North Midland region.*

The broad characteristics of the industrial structure of each region, as reflected in the distribution of its insured employees, are shown in Table 2.

Regional insured employment figures are available for 1939, 1947 and 1948–50, but the pre-1948 figures cover a much smaller proportion of the total population than the figures available as a result of the National Insurance Act. Hence it is not possible to analyse in detail changes in the regional patterns of industrial employment between, say, 1939 and 1948. Nevertheless, it is possible to see that over the period 1939–1950 the broad picture of regional employment patterns has not greatly changed. The chief agricultural regions throughout the period are Northern Ireland and Eastern region, the chief mining regions are Northern region and Wales and the chief manufacturing regions are Midland and North-western regions: London and the South-east and the two adjoining regions—Eastern and Southern—together with the South-western

* Coal Board Divisions differ, of course, from Standard Regions, but Coal Board areas are sufficiently small to make it possible, in principle at any rate, to build up to Standard Regions.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

region, have a relatively high proportion of workers in the service industries, and Scotland does not diverge greatly from the pattern for the United Kingdom as a whole.

2. *The Regional Wage Levels*

To the extent that the boundaries between the regions are artificial and the regions themselves administrative rather than economic entities, the differences between their average earnings levels are less striking or significant. Nevertheless there are interesting differences in regional earning power, as can be seen from Tables 3 and 6.

TABLE 3

Regions Grouped by Estimated Average Level of Earnings

(U.K. average = £315)

	Average annual earnings per earner (£)
Above average, i.e., above £325	
1. London and the South-east	341
Average	
2. Midland	320
3. Northern	316
4. North Midland	315
5. Wales	314
6. North-western	308
7. East and West Ridings	308
8. Eastern	307
Below average, i.e., below £305	
9. Southern	302
10. Scotland	300
11. South-western	295
12. Northern Ireland	249

Taking earnings from employment as a whole, the highest rate of earnings per earner is to be found in London and the South-east, where the average rate of earnings from all industries amounts to £341 per employee, as compared with a national average of about £315 per annum. The group with the lowest rate of earnings (less than £305 per annum) covers the south of England, Scotland and Northern Ireland. The regions in the middle and northern section of England and Wales all fall into the category of average earners with an average per earner of £305 to £325 per annum.

If we consider estimated rate of earnings by industry rather than by region the variation is very much greater, and gives some indication of how much wider might be the variations between smaller or more specialized regions. The industries which appear to yield the highest rate of return per employee are the professional industries (including insurance, banking and finance, public administration and defence, and professional services in general), the nationalized industries (mining and quarrying, with an average of £385, transport, and gas, electricity and water), and certain other manufacturing industries (metals, chemicals, engineering, shipbuilding, and vehicles, and paper and printing). At the other end of the scale, there are textiles and clothing manufactures with an average per earner of only £256 and £237 respectively, agriculture, etc., with £279 and distribution with £278, miscellaneous services £223, and certain other light manufacturing industries (principally wood and cork and rubber, food, drink and tobacco, and other metal goods). In interpreting these figures it should be remembered that the averages per earner are calculated in relation to estimated annual averages of *insured employees*.

It is to be expected that the position of a region in the average earnings scale would generally be positively correlated with the relative proportion of its workers employed in industries with high earning power per earner. An examination of the percentages employed in industries earning well above the average bears this out. Table 5 shows for 1939 and 1948 what percentage of the insured workers in each region were in industries with a high average earnings per earner, defining the 1948 average on the basis of the estimates shown in Table 4 and the 1939 average on

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Industries Grouped by Estimated Average Level of Earnings
(U.K. average = £315)

	Average annual earnings per earner (£)
Above average, i.e., above £325	
1. Insurance, banking, finance	457
2. Mining and quarrying	385
3. Transport	370
4. Metal manufacture	367
5. Vehicle manufacture	355
6. Public administration and defence	348
7. Professional services	345
8. Gas, electricity and water	344
9. Chemicals	329
10. Engineering, shipbuilding, etc.	328
Average	
11. Paper and printing	324
12. Other manufacturing	318
13. Building and contracting	317
14. Leather and fur	313
15. Treatment, non-metalliferous mining products	312
16. Precision instruments	310
17. Wood and cork manufactures	307
Below average, i.e., below £305	
18. Other metal goods	298
19. Food, drink and tobacco	293
20. Agriculture, forestry and fishing	279
21. Distribution	278
22. Textiles	256
23. Clothing	237
24. Miscellaneous services	223

TABLE 5

Percentage of Insured Employees in High-earning Industries
(Figures in brackets indicate regional rankings)

Regions Ranked in Order of Average Earnings per Earner in 1948	1939 (%)	1948 (%)
1. London and South-east	30 (10)	49 (4)
2. Midland	38 (3)	51 (3)
3. Northern	55 (2)	61 (1)
4. North Midland	34 (7)	47 (8)
5. Wales	57 (1)	61 (2)
6. North-western	32 (9)	46 (9)
7. East and West Ridings	37 (4)	48 (6)
8. Eastern	36 (11)	40 (11)
9. Southern	34 (6)	48 (5)
10. Scotland	36 (5)	47 (7)
11. South-western	33 (8)	46 (10)
12. Northern Ireland	n.a.	35 (12)

the basis of the estimates made for 1938 by Agatha Chapman (Chapman, 1953). If we attempt to compute rank correlation coefficients comparing regional rankings in respect of these employment percentages and average earnings for 1948, we find, as we should expect, that there is a significant positive correlation. Using the coefficient of disarray suggested by M. G. Kendall (1948) we get a coefficient with significance beyond the 1 per cent. probability level.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It is perhaps even more interesting to note that the correlation is not exact, and that in 1948 the first and second in the average earnings scale become fourth and third respectively when ranked according to percentage in high earning industries; and also that Scotland which is seventh in its dependence on high earning industries is tenth in the average earnings scale, while North Midland which is fourth in level of earnings is eighth in enjoyment of high earning industries.

These considerations would suggest that some regions rise high in the average earnings scale for other reasons than their enjoyment of high earning industries and that some regions sink low in it, in spite of their relatively large share of high earning industries.

Arguing from *a priori* grounds it is possible to distinguish at least three major factors or groups of factors which would influence the actual level of earnings per earner in each region. The first of these might be called the "industrial structure" factor: a region with a high proportion of high earning industries will tend to be a region with high overall average earnings per earner. The second might be described in terms of the "composition of the labour force": a region with a high proportion of women and/or of juveniles in its labour force will tend to have a low level of earnings per earner. The third factor (or set of factors) is more difficult to define causally though its effects are obvious: the outstanding example is London, which normally pays higher rates of wages than any other region, but it is not the only region, for which we can suspect a local propensity to pay higher (or lower) wages than the national average. For want of a better name we shall call the third set of factors the "regional earnings rate" factor influencing the actual level of earnings.

The first of these factors can be considered by calculating regional averages on the assumption that the average rate of earnings is the same for all regions. The resulting regional variations can then be attributed to differences in industrial structure. The regional differences in composition of the labour force could be studied by applying the national percentages of women and juveniles employed in each industry to the total employed for each region in order to obtain a base point from which to measure actual variations.* The third set of factors, which we have chosen to regard as the more specifically local influences, could be isolated in principle by calculating a regional average earnings index which was weighted first by the national percentages of men, women and juveniles employed in each industry (i.e., by assuming away regional variations in the composition of the labour force), and then by the national percentages of insured employed in all industries (i.e., by assuming a constant industrial structure throughout the United Kingdom).

If we adopt the notation used by Professor Bowley in his analyses of factors determining changes in average wages over time (Bowley, 1947, p. 16) we can write:

$N_1 N_2 \ldots$ for numbers employed in each industry of the U.K.
$n_1 n_2 \ldots$ for numbers employed in each industry of the given region.
$W_1 W_2 \ldots$ for average earnings in each industry of the U.K.
$w_1 w_2 \ldots$ for average earnings in each industry of the given region.

The formula for an index of actual average earnings is then

$$\frac{\Sigma nw}{\Sigma n} \div \frac{\Sigma NW}{\Sigma N} \quad \text{or} \quad \frac{\Sigma nw}{\Sigma NW} \times \frac{\Sigma N}{\Sigma n}.$$

The Industrial Structure index suggested above becomes

$$\frac{\Sigma nW}{\Sigma n} \div \frac{\Sigma NW}{\Sigma N} \quad \text{or} \quad \frac{\Sigma nW}{\Sigma NW} \times \frac{\Sigma N}{\Sigma n},$$

and the Regional Earnings Rate index before allowing for regional differences in composition of the labour force is $\frac{\Sigma Nw}{\Sigma NW}$. By writing subscripts to relate these symbols to males, females and juveniles respectively we can introduce regional weights for men, women and juveniles employed into this Regional Earnings Rate index as follows:

* E.g., on the lines suggested by C. E. V. Leser (1952 pp. 326–344). Dr. Leser applies national percentages of women employed in each of 164 industries to total employment figures by regions and obtains for each region an "expected" percentage of women employed in each region. It is this "expected" percentage which provides the standard against which can be measured actual regional variations.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$\frac{\Sigma N_M w_M + \Sigma N_F w_F + \Sigma N_J w_J}{\Sigma NW}.$$

It will be noted that both for the Industrial Structure index and for the Regional Earnings rate index, the formula suggested involves the use of United Kingdom weights. If we were interested primarily in the variations between the United Kingdom and its regions we could equally well have used regional weights. The Industrial Structure index would then become $\frac{\Sigma nw}{\Sigma Nw} \times \frac{\Sigma N}{\Sigma n}$, and the Regional Earnings Rate index would become $\frac{\Sigma nw}{\Sigma nW}$. Since we were at least as interested in the variations between regions it seemed better to adopt national weights throughout. If we adopt this approach, however, we lose sight of the convenient identity between the indices of the two sets of factors influencing average wages and the index of average wages itself. Professor Bowley expressed this identity as follows:

$$\frac{\Sigma nw}{\Sigma NW} \times \frac{\Sigma N}{\Sigma n} = \frac{\Sigma nw}{\Sigma nW} \times \frac{\Sigma nW}{\Sigma NW} \times \frac{\Sigma N}{\Sigma n},$$

and it could equally well be written

$$\frac{\Sigma nw}{\Sigma NW} \times \frac{\Sigma N}{\Sigma n} = \frac{\Sigma Nw}{\Sigma NW} \times \frac{\Sigma nw}{\Sigma Nw} \times \frac{\Sigma N}{\Sigma n}.$$

Accordingly in Table 6 the indices are calculated from both points of view. R_1 and P_1 are based on United Kingdom weights and R_2 and P_2 are based on regional weights. Hence $R_1 \times P_2 = R_2 \times P_1 =$ the actual average earnings index. These calculations are based on the results for all industries of the United Kingdom, as shown in Table 1.

The two methods of weighting produce results which do not differ greatly from one another, although they do alter the regional rankings in some instances. The differences are produced by correlations between variations in numbers employed and variations in average wages. Thus we would expect R_2 to exceed R_1, where higher average wages (relatively to the United Kingdom) tend to be correlated, industry by industry, with a higher proportion of numbers employed. As can be seen from Table 6, R_2 does tend to be greater than R_1 in the majority of cases, though only

TABLE 6

Indices of Regional Variations in Earning Power

Regions Ranked in Order of Earnings per Earner	*Actual Average Earnings per Earner*	*Industrial Structure*		*Regional Earnings Rate*	
		P_1	P_2	R_1	R_2
	$\frac{\Sigma nw}{\Sigma NW} \times \frac{\Sigma N}{\Sigma n}$	$\frac{\Sigma nW}{\Sigma NW} \times \frac{\Sigma N}{\Sigma n}$	$\frac{\Sigma nw}{\Sigma Nw} \times \frac{\Sigma N}{\Sigma n}$	$\frac{\Sigma Nw}{\Sigma NW}$	$\frac{\Sigma nw}{\Sigma nW}$
1. London and South-east	108·2	100·6	100·9	107·2	107·6
2. Midland	101·5	101·7	102·7	98·8	99·8
3. Northern	100·3	103·6	106·3	94·4	96·8
4. North Midland	100·0	99·1	100·8	99·2	100·9
5. Wales	99·5	104·7	105·3	94·5	95·1
6. North-western	97·7	98·4	98·1	99·6	99·3
7. East and West Ridings	97·6	99·6	100·6	97·1	98·1
8. Eastern	97·4	97·3	98·7	98·6	100·1
9. Southern	95·8	98·8	98·9	96·9	97·0
10. Scotland	95·1	99·9	100·3	94·9	95·2
11. South-western	93·5	99·0	98·7	94·7	94·5
12. Northern Ireland	79·0	94·1	92·8	85·2	84·0

significantly so for Northern, North Midland and Eastern regions, in each of which the region makes a better showing when the indices are calculated with regional weights than when they are calculated with national weights. The only region for which the regional weightings give an index which is as much as 1 per cent. smaller than the national weightings is Northern Ireland,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and in this case the basic estimates are still too weak to justify constructing a hypothesis on so small a difference.

The broad conclusions suggested by this table are not, however, seriously affected by the system of weights adopted. In any case it would appear that Northern region and Wales owe their relatively high position in the average earnings scale largely to their "favourable" industrial structure, whereas, as we might have expected, the predominantly higher average earnings in London and the South-east can be attributed to a very high regional earnings rate. It is interesting to note that Scotland with an "average" level of industrial structure is pulled down into tenth place on the average earnings scale by a relatively low regional earnings rate. In South-western and Southern regions also there seems to be a tendency for a relatively low regional earnings rate to depress the actual level of average earnings.

Unfortunately we do not have enough data on the regional distribution and the average earnings of women and juveniles to be able to eliminate the effects of the regional composition of the labour force from the regional earnings rate index. If we consider the results reached by Dr. Leser (Leser, 1952), however, we find that the regions with significantly more women employed than could be accounted for in terms of their industrial structure are Scotland and the Midlands, and the regions with significantly less are Southern, Eastern, and South-western. It is possible, therefore, that both Scotland and the Midlands would improve their position in the regional earnings rate scale if we could eliminate the effect of a higher relative proportion of women employed, and that Southern, Eastern and South-western regions would fall in the scale.

So far we have considered the regional results only in terms of the level of earnings per earner. If we take a broader view and consider the level of incomes per family (or per head of total population in the region), it becomes necessary to qualify some of the judgements made above about the favourable or unfavourable effect of a given industrial structure. An industrial structure which offers wide opportunities of employment to women and juveniles may produce a relatively high level of family income side by side with a relatively low level of earnings per earner.

Table 7 which lists the regions in order of level of earnings per earner shows their levels of earnings per head of total civilian resident population in each region.

TABLE 7

Regional Earnings from Employment Per Head of Total Population, 1948

Figures in brackets indicate rank order

Regions Ranked in Order of Average Earnings per Earner	*Index of Average Wages and Salaries per Head of Total Population U.K.* = 100
(1) London and South-east	121 (1)
(2) Midland	110 (2)
(3) Northern	92 (6)
(4) North Midland	100 (5)
(5) Wales	82 (9)
(6) North-western	104 (3)
(7) East and West Ridings	102 (4)
(8) Eastern	82 (10)
(9) Southern	85 (8)
(10) Scotland	92 (7)
(11) South-western	81 (11)
(12) Northern Ireland	66 (12)

From this it can be seen that North-western region's "unfavourable" industrial structure, when considered in terms of earnings per earner, has a relatively favourable effect on earnings per head, for the region rises from sixth place to third place in this scale. Scotland also improves its position (from tenth to seventh), and East and West Ridings region rises from seventh to fourth in this scale. Conversely, Wales and Northern region drop from fifth to ninth and from third to sixth respectively.

Now, although these broad conclusions are unlikely to be seriously affected, it should be recognized that the index calculated in Table 7 is a particularly crude index of regional variations in employment incomes per head, because those employed in a given region are not necessarily

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

drawn from the resident population of the region. Where there is an influx of labour from another region, the per head index calculated in this fashion overstates actual per head incomes retained in the region. Conversely, per head incomes are under-stated for regions whose residents travel across the regional borders to work for wages or salaries. London is the outstanding example of a labour-receiving region, and it is unlikely that the level of retained incomes per head of total population in London and South-east is as much as 21% above the United Kingdom average. It may be, too, that the Midland region figure is an over-statement for the same reasons. On the other hand, it seems probable that the population of Eastern region, which constitutes an important dormitory area for London, receives more income from employment than the index in Table 7 would suggest.

The analysis which has been briefly suggested in this paper is designed as an exploratory excursion into a subject which we hope to be able to examine more intensively when statistical material on which we are still working, or which is being processed in government departments for publication, is fully available. It may be of some interest to conclude by indicating what we expect to be the main results and directions of our further inquiries.

A strengthening of our estimates for the service industries (particularly for distribution, finance, public administration and professional services) will reduce the number of instances in which we are forced to assume that the regional average approximates to the national average. Consequently we may expect one result of a more reliable set of estimates to be an increase in the amount of regional variation as measured in the actual earnings rate index, and *a fortiori*, in the regional earnings rate index. Unless the service industries show greater variations in average earnings from region to region than, say, manufacturing industries, we should not expect the broad picture suggested by the indices in Table 6 to be greatly changed, but there may well be appreciable shifts in the relative position of various regions. In particular, for example, since we have usually been able to estimate regional variations for London when no other regional information was available, we suspect that the level of earnings in London and South-east is not as much greater than that of all other regions as it would appear from our calculations so far.

There is no reason to suppose that the use of regional results of the Census of Production will appreciably alter the results of our calculations based on Earnings Inquiry data. It may be, however, that average salaries vary less (or more) regionally than average wages, and this would affect our results for industries where we have assumed that the index of wage variations could be applied to the total of wages plus salaries.

What we should hope to be able to do as a result of the fuller publication both of regional Census of Production results and also of the Board of Inland Revenue's Income Census results, is to widen the scope of our study of the nature of regional variations in incomes from employment. It will be possible, for example, to compare variations in average earnings with variations in net output, industry by industry in each region. As a preliminary experiment in this direction we have taken some forty industries for which regional variations are fully shown in the final Reports so far published and compared regional rankings in respect of (*a*) average wages and salaries, (*b*) average net output excluding wages and salaries, and (*c*) the percentages which wages and salaries take of net output. By calculating the coefficient of disarray suggested by Kendall (1948) we have obtained rank correlation coefficients which suggested a positive correlation between (*a*) and (*b*) and no correlation between (*a*) and (*c*). The results are far too inadequately based to be conclusive, but they do suggest directions in which we can hope to pursue this kind of analysis when the full regional results of the Census are available.

Finally, now that the results of the Income Census carried out by the Board of Inland Revenue in 1950 are available by counties, it is possible to consider regional variations in wages and salaries for much smaller and economically more significant areas than the Standard Regions. We are now able to consider variations in size distribution of incomes from employment for relatively small geographical areas of the United Kingdom. When the results of the Ministry of Labour Earnings Inquiry data are available by regions over a period of years we shall be able to analyse temporal variations in the regional rates of earnings from employment.

References

Board of Inland Revenue (1952 and 1953). *Report of the Commissioners . . . for the year ended 31st March.* 1951 and 1952. London: H.M.S.O. Cmd. 8436 and Cmd. 8726.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Board of Trade (1951), "Summary of the first preliminary results of Census of Production for 1948", *Board of Trade J.*, **161**, 280.
Bowley, A. L. (1947), "Wages, earnings and hours of work, 1914–1947, United Kingdom", *Lond. Camb. Econ. Service*, Spec. Memo. 50.
Central Statistical Office (1951), *National Income and Expenditure*, 1946–1951. London: H.M.S.O.
Chapman, Agatha L., and Knight, Rose (1953). *Wages and Salaries in the United Kingdom*, 1920–38. No. 5 in the joint series of Studies in the National Income and Expenditure of the United Kingdom published for the National Institute of Economic and Social Research and the Department of Applied Economics. Cambridge University Press.
Kendall, M. G. (1948), *Rank Correlation Methods*. London: Griffin.
Leser, C. E. V. (1952), "Men and women in industry", *Econ. J.*, **62**, 326.
Ministry of Labour and National Service (1948), "Number employed; industrial analysis", *Min. Labour Gazette*, **56**, 356.
—— (1951), Tables relating to Employment and Unemployment in Great Britain 1948, 1949, and 1950. *Regional and Industrial Analysis of Employees and Insured Persons*. London: H.M.S.O.
Office Management Association (1950), *Clerical Salaries Analysis* 1950. London: O.M.A.

Discussion on Miss Deane's Paper

Mr. Ainsworth: It gives me great pleasure to move a vote of thanks to Miss Deane for her paper. The paper marks an important step forward in the statistics concerning the wages and salaries bill in this country. Not many years ago the only statistics of the total wages bill were those compiled at long intervals by Bowley, Stamp and Colin Clark. Now we have regular statistics of income from wages and salaries compiled by the Central Statistical Office based on regular reports by the Ministry of Labour and, in connection with the Census of Production, by the Board of Trade.

Miss Deane has carried the process a step further by attempting to analyse the total by regions. The results, as she has said, are tentative at present, but the attempt has been obviously well worth while, and, what is perhaps equally important, it has brought to light important gaps which still exist in the material. Miss Deane has emphasized the difficulties and the gaps, especially in the appendix to the paper.

I have no observations on the first part of the paper beyond one small query about the high level of earnings in insurance, banking, and finance. The figures look to me rather high. There are considerable numbers of juveniles and females in this group of industries, but the basis for these figures is perhaps, as Miss Deane has said, as slender as any in the paper. Fuller information might produce a lower average.

With regard to the second part of the paper, there are of course extraneous factors which require elimination in attempting to arrive at an index of average earnings rates. Miss Deane mentions particularly differences in industrial structure and in the composition of the labour force. The differences in the industrial structure are quite a complex matter, and I am not sure that the results of her elimination of this factor on the basis of relative total earnings are very realistic. I think that by using this method she may have eliminated some of the differences in the average annual earnings rate itself.

The most important factor to be eliminated is, it seems to me, that of differences in the composition of the labour force in the different regions. These may be accounted for by the differences in the proportions of men, women and juveniles, but they also are accounted for by differences in the proportions of time workers and piece workers and of skilled and unskilled workers. There are, in addition, differences in the proportions of highly paid salaried workers. I think that something more could be done with regard to differences in the proportion of men and women. Whether Miss Deane will be able to extract from the departments concerned further information on this point I am not sure, but something more might be available. I am doubtful, however, whether much can be done to eliminate the effect of the other factors I have mentioned.

A further point. An index of average earnings covering men and women, boys and girls is rather an indefinite sort of thing, and I should prefer to see a separate index of average earnings rates for men and women. I do not think there is need to worry about the juveniles.

My last suggestion refers to Miss Deane's remark about the differences peculiar to the regions based to some extent on the differences in geographical structure. On that point some light could be obtained by attempting to construct an index of regional rates of wages. This index would be very largely affected by the prevalence or otherwise of important industrial towns or conurbations in the different regions. There is ample information available about rates of wages. I have examined the national wages scheme for the building industry. Under this scheme there are four grades of towns: grade A, with a rate for craftsmen of 3*s.* 4½*d.*; A1, with a rate of 3*s.* 4*d.*;

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A2, with a rate of 3*s.* 3½*d.*, and A3, with a rate of 3*s.* 3*d.* In the North-West Region 65 per cent. of the named localities are in grade A, 19 per cent. in A1, 6 per cent. in A2, and 10 per cent. in A3. In the South-West Region only 2 per cent. are in grade A, 11 per cent. in A1, and 87 per cent. in A2. I have also the figures for the Eastern Counties: 17 per cent. in grade A, 30 per cent. in A1, 21 per cent. in A2, and 33 per cent. in A3.

Here are the beginnings of a regional index of wage rates for the building industry, and I am sure that similar indices could be compiled for most other industries, and combined into an overall regional rates of wages index. I hope the Department of Applied Economics will be able to follow out these lines of thought, and that a future paper may be presented to the Society embodying the results of the work still going on, together with some additional information on the lines I have suggested.

Mr. T. M. RIDLEY: I have much pleasure in seconding the vote of thanks. Miss Deane is to be congratulated on her timely and interesting piece of work.

I should like to comment in some detail on one or two specific items in the paper. Firstly, I should like to refer to the discrepancy mentioned in the last paragraph of Section II. In the Blue Book on *National Income and Expenditure, 1946–1951*, the wage and salary bill for building and contracting is based on a wide definition of the industry, which includes persons employed in building and civil engineering work, not only in gas, electricity and water undertakings but also in transport. This, no doubt, accounts for some of the differences between the figures for these industries as shown in the Blue Book and as shown in Table 1 of Miss Deane's paper. In the manufacturing industries, where the basic figures in both cases are derived from the same source, namely, the Census of Production, the differences are quite small. In agriculture, forestry and fishing the calculation of the wage and salary bill has always been a troublesome business, but after the experience gained over a number of years the compilers of the Blue Book figures for this industry group were beginning to feel reasonably confident about their accuracy.

While Ministry of Labour employment figures play only a minor role in the calculation of the wage and salary bills for the industries I have mentioned, they are, nevertheless, fundamental to the calculation as a whole; they provide a guide to the total number of persons to be included somewhere or other in the various industrial groupings. The definition of employment used by the Ministry, however, is such that the formula "number employed times average earnings" always tends to produce an inflated answer, hence the employment figures may have to be adjusted. It is necessary, for example, to make allowances for complete weeks of voluntary and involuntary absenteeism and for unemployed persons who, having insurance cards, have failed to register at the Labour Exchanges, unless these classes of persons have already been taken into account in the calculation of the average earnings figures to be used. The excess of the total wage and salary bill in Table 1 over the total in the Blue Book may owe something to this cause.

It is obviously unsatisfactory to attempt to discuss the details of these complicated calculations without the aid of working sheets, but there is one point which I might usefully mention at this juncture. The people responsible for calculating the Blue Book wage and salary figures are, I am assured, as they always have been, willing to discuss the basis of their calculations in the greatest degree of detail, either with Miss Deane, or with any other fellow workers in this field.

In Section III Miss Deane tilts her lance at the Standard Regions. At this point the underlying purpose of her study becomes rather obscured. If she wishes to produce some sort of regional-industrial stratification of the country for sampling purposes, her criticisms might be justified, but if she merely wants an informative breakdown of the home market, her dissatisfaction with the Standard Regions does not seem to be altogether warranted. The Standard Regions were set up to facilitate the transaction of regional business between Departments and, with minor exceptions, their boundaries lie along national and county boundaries. They are readily identifiable and therefore of general public interest—a matter of considerable importance. Moreover, many useful statistics are already based on them. Although they have been chosen for so-called administrative reasons, on analysis many of these reasons will be found to be broadly economic in character. The fact that the Standard Regions do not provide a set of highly specialized industrial regions does not necessarily imply that there is some other acceptable regional system which will.

In a relatively small and highly industrialized country like the United Kingdom it is easy to underestimate the difficulties of producing economically specialized regions. For example, the regional boundaries adopted by the nationalized industries are so varied that a glance at them is enough to discourage any search for a common system. Several ignore the Welsh border; at least one appears to ignore the Scottish border. In the narrow economic sense there is probably no reason why one side of the Cheviots should be distinguished from the other, but salesmen based on Newcastle and Edinburgh respectively, together with the ordinary Northumbrian and

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Roxburgh citizens, would, I am sure, prefer to regard the Cheviots as a frontier of their local interests.

I will conclude my remarks with a brief reference to Miss Deane's results. The Regional Earnings Rates shown in Table 6 are particularly interesting, and it would be still more interesting to have a clear idea of what they really mean. I think I am right in saying that nowhere in the paper is there any direct evidence that the same classes of workers get different rates of pay in the different regions for the same kinds of work. After allowing for the differences due to age and sex, a finer industrial classification based on processes as well as products might eliminate all residual differences. However, this is just a possibility, and while it should not be forgotton, it is probably more reasonable to accept the assumption that the Regional Earnings Rates represent real differences which require to be explained. Following up this assumption, I looked to see whether the Regional Earnings Rates had any relationship with regional unemployment rates, and found that the rankings of the two phenomena, while not identical, were very close. To give the figures a rough objective test, rank correlation coefficients were calculated, the results being $+0{\cdot}73$ and $+0{\cdot}80$ using Miss Deane's R_1 and R_2 respectively.

On percentage unemployment, London and the South-East ranked fourth, but on Regional Earnings Rates it ranked first. This rather low unemployment ranking may be due to the high rate of labour turnover in the region, since turnover must have been an important factor in the make-up of the small volume of unemployment we had in 1948. Accordingly, a regional break-down of the Ministry of Labour's turnover figures for employees in manufacturing industries was used to derive conservative but rather arbitrary factors to adjust regional unemployment percentages for differences in turnover rates. Rank correlation coefficients based on regional employment rates adjusted to remove the influence of varying rates of labour turnover were appreciably better, being $+0{\cdot}80$ with R_1 and $+0{\cdot}83$ with R_2.

If it is accepted that real differences in Regional Earnings Rates do exist, these results suggest that the explanation might chiefly lie in the ordinary laws of supply and demand currently operating in partly non-competing regional labour markets. Ministry of Labour returns show that in any one industry overtime and short time are worked simultaneously and this rather encourages the view that there are local conditions which cause overtime or short time to be worked and, possibly, the payment of more or less attractive piece-rates and time-rates in the various regions—a state of affairs which tends to persist owing to the low geographical mobility of labour.

Mr. Colin Clark: It is with great pleasure I return to the Society after sixteen years' absence, but I am afraid I shall be a Rip Van Winkle in the discussion. I do not want to criticize Miss Deane's statistical technique, because, as we all expected, it is work of the highest quality. I should like to point out the extreme importance for three reasons, as I believe, of the subject in which she is engaged: (1) Commercially the great importance of regional income statistics to business practice. (2) Regional differences of industrial costs may have the effect of attracting manufacturers into remoter areas and away from congested areas. (3) The most important reason of all is the use of regional incomes in planning. That is particularly where the statistician comes in. I made a preliminary study myself of this field, published in 1945 in *Econometrica*. In studying regional employment useful progress can be made by studying the number of commercial and service workers per million pounds of regional income. In this respect some other countries have done better than Great Britain, notably the United States, Canada, and Australia, and, before the war, Germany. Sweden also has done fairly well—Norway and Denmark not quite so well. I think we all look forward with pleasurable anticipation to the future work coming from the Board of Trade and the Board of Inland Revenue. The most difficult point of practice which has already arisen in the United States and elsewhere is the distinguishing of incomes by region of origin and by region of residence. The Board of Trade studies dealing with industrial production will, of course, give production by regions, and in any proper study we shall have to have two sections, one dealing with origins and the other with residence.

Mr. E. J. M. Buckatzsch: It is very satisfactory to hear that positive results have been obtained in the work on regional incomes in progress at Cambridge, even though these results are somewhat tentative. One may perhaps look ahead and hope for progress along two lines. On the one hand one hopes it may be possible to construct genuine annual series of regional earnings estimates like those Miss Deane has described. Such a series would throw interesting light on the fine structure of the economy by enabling us to trace the regional impact of charges in total earnings and employment. I had always supposed that the regional pattern of earnings and incomes was very stable, but some recently published figures show that considerable re-ranking of regions by earnings may take place in quite short periods. On the other hand one looks forward to the extension of Miss Deane's work on incomes from work to other categories of income. Here

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

one may foresee considerable difficulty in distinguishing income generated from income received in regions, because much of the published information, such as the Inland Revenue statistics, does not relate unequivocally to either. It is unfortunate that the Standard Regions have, in general, limited economic significance, and that important economic effects are to some extent masked by the heterogeneity of the Regions.

Professor G. A. BARNARD: It has been asked whether it can be shown that the same work may carry different rates of pay in different parts of the country. In this connection I should like to draw attention to the source of ancillary information which exists in the Rules Books of Trade Unions. If my recollection is right there are (or at least, were) considerable variations in the rates for skilled toolmakers for different districts of the Amalgamated Engineering Union, for skilled cabinet makers in the National Union of Furniture Trade operatives, and there were, before the war, variations in the minimum rates for agricultural workers. It is true, of course, that in times of relative prosperity union or statutory minima are not very precise estimators of wages rates; but their efficiency in this respect is better in times of economic depression.

Miss DEANE subsequently replied in writing as follows:

One of the advantages of presenting an interim report on an investigation of this kind is that it makes comment and criticism doubly welcome to an investigator who is in the midst rather than at the end of the inquiry. I should like to thank warmly all those who contributed to the discussion on this paper.

The comments on the Industrial Structure index and the Regional Earnings rate index were particularly interesting. I would agree with Mr. Ainsworth and Mr. Ridley that there is scope for further work on these concepts, designed to distinguish more effectively the major factors contributing to regional differences in average earnings. Mr. Ainsworth stresses, rightly I believe, the importance of the composition of the labour force as a contributory factor. The results of the 1 per cent. sample of the 1951 Population Census confirm this point of view by showing that there are striking regional variations not only in the sex composition but also in the age composition of the labour force. When all the definable factors have been accounted for there remain the specifically regional influences which give rise to different rates of pay for the same work; as several speakers suggested, it would be interesting to compare a regional earnings rate index from which as many extraneous factors as possible had been eliminated, with a regional wage rate index based on data for those industries where national wage schemes illustrate geographical differences. It is of some interest to observe, however, that the specifically regional influences do not affect wages and salaries alone. An analysis of variance applied to 40 industries, for which the final reports of the 1948 Census of Production provided a full regional analysis, gave significant evidence of the existence of regional influences on variations not only in average wages and salaries but also in average net output, excluding wages and salaries. A positive co-variance existed between regional variations in average wages and salaries and in average other net output for this group of industries.* These results cannot be regarded as conclusive until the full results of the 1948 Census of Production are available, but they do suggest that we may have to look further than the "ordinary laws of supply and demand for labour" in explaining regional influences on levels of earnings.

Mr. Clark and Mr. Buckatzsch drew attention to the importance of distinguishing between an allocation of incomes by region of residence and an allocation by region of work. The estimates in this paper represent an allocation by region of labour exchange which can be regarded as a fairly close approximation to region of work. Until the final results of the 1951 Census of Population are available to provide an industrial analysis of the occupied population by region of residence as well as by region of work it will not be possible to do more than guess at the possible differences in the results of the two methods of allocation. A comparison of the results of the 1 per cent. sample, which gives an industrial analysis by region of residence, with the Ministry of Labour employment analysis suggests that the regions with a net inflow of labour are London and the South-east, North-western, and East and West Ridings, and that the regions with a net outflow are Eastern, Southern, South-western and Wales. This in its turn suggests the suspicion that we may have overestimated the relative position of London, North-western and East and West Ridings in the "average per head of total population" scale (Table 7), and underestimated the relative position of Eastern, Southern, South-western and Wales. It does not, however, help us to judge how the level of earnings per earner at work in a region (Tables 3 and 6) might differ

* The selection of industries for this analysis of variance was determined by order of publication of the final reports, and includes those for which a full regional analysis had been published by the end of 1952.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

from the level of earnings per earner resident in a region. At present our only source of information on the average earnings of residents in different regions is the recently published material from the Inland Revenue Income Census, which by classifying results according to region of main assessment provides an approximation to a region of residence definition. These relate to the year 1949–50 and to assessed earners only, so that they are not directly comparable with the results given in this paper. It is interesting to note, however, that estimates of average assessed wages and salaries derivable from the Income Census results gave a rank ordering of the regions which is very close to that calculated for Table 3 of this paper ; the only differences are that estimates based on Income Census data place Northern region 5th instead of 3rd, East and West Ridings 3rd instead of 7th and Wales 7th instead of 5th.

Mr. Ridley's comment on the Standard regions seems to call for some reply, although it is difficult to say much more than I have already said without being fairly specific. It is true that different analytical purposes call for different geographical breakdowns, and hence that no standard breakdown will suit all purposes. It is also true that it is convenient to have standard regions following county or country boundaries as far as is reasonable. The main trouble with the present system of standard regions, however, is that it is too broad to be adaptable to varying purposes: the regions tend to be too large and heterogeneous for the variations to be sufficiently significant. It is of course possible by looking, as Mr. Ridley has done, at the regional boundaries of the nationalized industries to produce examples of less significant regional breakdowns inspired by more limited administrative horizons ; but it is also possible to suggest a number of improvements in the present system. There is no question, for example, of ignoring the Welsh or Scottish borders, but the practice followed in the 1935 Census of Production of splitting Wales into two and Scotland into four regions provided more informative results than the 1948 Census, which treated them as single regions.

Finally, in response to Mr. Ainsworth's suspicion that the national average estimated for the insurance, banking and finance group of industries has been pitched too high, I might perhaps add that it includes an allowance for employers' superannuation contributions. This tends to raise the relative importance of this and the public administration and professional groups, for we have not included employers' national insurance contributions in average wages and salaries for other industries.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Thomas Daniel Alcock.
Peter Thomas Bauer.
Dattatraya Shripad Dani.
John Gratwick.
A. V. Kesavan.
Abu Hamed Khandker.
Ernest Guy Libby.
William Roderick Matheson.
William L. B. Nixon.
Harold Stanley Rich.
William Shakespeare.
Betty Timperley.
Cho-Yook Tye.
Valerie Wright.
Benjamin Seew Malek.

Corporate Representatives.

Denis Ashton, *representing* British Timken, Ltd.
Stephen Snow Menneer *representing* The Ministry of National Insurance.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A Sampling Design Used by the Ministry of Education

By G. F. Peaker

[Read before the Royal Statistical Society, February 25th, 1953,
Professor A. Bradford Hill, C.B.E., Ex-President in the Chair]

I. Introduction

This paper describes and illustrates a sampling design used by the Ministry of Education last year. The novel feature of the design was the adaptation of two-stage stratified sampling to the pattern of our educational system with the object of minimizing the cost per unit of information. Hitherto sampling inquiries in education have generally taken the form either of single-stage sampling, with individual pupils as the sampling units (in which case the real cost is high), or of purposive sampling (in which case the sampling error is unknown), or of strictly localized sampling (in which case the sample itself can provide no ground for generalizing outside the locality). The design described below takes account of the structure of our system, in which the pupils are to be found in schools of various types, grouped in varying proportions in the areas administered by Local Education Authorities, and in which the current statistics of the Ministry of Education provide an excellent frame for drawing a sample of any kind.

There are, or so it seems to me, some misconceptions about the theory of sampling in many elementary text-books of educational psychology. In recent years, particularly in America, much attention has been given to constructing "objective" tests of various kinds, and providing them with "norms"—i.e., mean scores derived from samples of pupils. In the books such samples are frequently described as "representative" samples, but little is said about the population of which they are held to be representative, or of the grounds for supposing them to be so. Often such samples consist of pupils in schools which happen to lie ready to hand, and to be willing to co-operate in the work. This may in fact be all that is needed for the purposes in hand, which may really be to exclude from the test such questions as may appear on trial to be too hard, or too easy, or uncorrelated with the general direction of the test, to estimate an appropriate age allowance, and so on. For purposes like these such haphazard samples may be quite adequate. But it is frequently implied, in text-books and in test manuals, that they are adequate for much more. It is implied, for example, and indeed sometimes stated in terms, that a test norm so derived represents an average for the whole country. To imply this is to ignore the fundamental principles of all rigorous sampling, namely that the aggregate to be sampled must first be precisely specified, then divided into sampling units (in such a way that these sampling units together contain the whole aggregate), and that a sample is then drawn in such a way that every sampling unit has a specifiable chance of appearing in the sample.

It is only under such conditions that there can be any assurance that a small sample is really representative of a large aggregate. Fortunately for most of the purposes for which tests are used it is not strictly necessary that there should be such an assurance. But where it is necessary the conditions of rigorous, as opposed to haphazard, or even purposive, sampling should be secured. In the first of the inquiries described below the main object was to obtain an estimate of the mean score on a certain reading test of pupils aged fifteen in grant-aided schools in England and Wales. The problem was to reconcile the administrative requirements of economy and convenience in collecting the information with the mathematical requirements that the sample should be drawn in such a way that the estimate of the mean should be unbiased, and the sampling error both small and calculable.

II. Specifying the Population

For this first inquiry the population to be sampled was the population of pupils aged fifteen in grant-aided schools in England and Wales. Since the inquiry was held in the Spring term of 1952 pupils aged fifteen were defined as pupils born in January, February and March, 1937. Direct grant grammar schools were included, but special schools for handicapped pupils (e.g., schools

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

for blind, deaf, lame or epileptic children) were excluded, except for schools for the educationally sub-normal.

This population, or aggregate, can be divided into sampling units in many ways. The obvious sampling units are:

(*a*) The individual pupil.
(*b*) The school.
(*c*) The Local Education Authority area.

Every pupil belongs to some school, and every school lies in the area of some Local Education Authority (although the direct grant schools will not be administered by that Authority). Both (*b*) and (*c*) therefore satisfy the condition that they cover the whole aggregate. If they are used as sampling units it will still be possible to specify the chance of any pupil of appearing in the sample.

III. Drawing the Sample

The simplest plan in theory would be to take the individual pupil as the sampling unit. This would also have the advantage that for any given degree of accuracy the total number of pupils needed in the sample would be a minimum. But it would have the immense disadvantage that a random sample of pupils would be spread in practically as many schools as there are pupils in the sample, so that it would not comply with the administrative requirements of economy and convenience.

To take the schools as sampling units would be a more convenient plan, but this would still be subject to the disadvantage that the schools would be spread through practically every Local Education Authority area in the country. This is inconvenient administratively, and has the further disadvantage that it yields no information about differences between one area and another, since the sampling is not sufficiently intensive in any one area. For some secondary purposes of the inquiry areas were important domains of study.

It therefore seemed best to adopt a two-stage design, in which the first-stage sampling units were Local Authority areas, and the second-stage units were schools. All pupils within each selected school (and in the specified age range) would be included in the sample.

The next step was to decide what stratifications could usefully be made at each stage. At the first stage it would clearly be profitable to stratify areas into Urban and Rural, since, on the whole, Urban pupils could be expected to make higher scores than Rural pupils. Rural areas were defined as areas administered by Rural District Councils; all other areas as Urban. This meant that the areas of the County Local Education Authorities had to be subdivided into Urban parts and Rural parts. The County Boroughs and London formed, of course, part of the Urban stratum.

There is a very large range of size among Local Education Authorities; the coefficient of variation is considerably greater than one. I subdivided some of the larger areas, but since, for administrative reasons, the total number of areas in the sample had to be kept quite small, so that it was impracticable to stratify into size-groups, it seemed best to make the first-stage draw with probability proportionate to size. Greater variability was to be expected among the Rural than among the Urban areas, so that a larger sampling fraction was appropriate for the Rural areas; twelve Urban areas and five Rural areas were drawn, although only 11 per cent. of the population to be sampled is to be found in the Rural areas.

The draw was actually made by using two lists, one for the Urban and one for the Rural stratum, each arranged in a geographical order. Against each area in the list the number of pupils in the age-group was entered, and a running total was made. From a random starting-point a series of equal steps through the running totals picked out the necessary number of areas with probability of selection proportionate to size. It was not, of course, possible to know in advance precisely what the age-group in each school and area would be in the Spring term of 1952, but the number of pupils born in 1937, and on the school roll in January, 1951, seemed likely to furnish a sufficiently close approximation. This number was therefore used as the measure of size, and after the event a check was made which showed that, as was to be expected, the amount of coming and going during 1951 had been relatively small, not merely for areas but also for schools. It was, of course, only the net change which was relevant.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

When the areas had been drawn the next step was to draw the schools within selected areas. This was a more complex matter. There were five types of schools to be considered, namely Grammar, Technical, Modern, All Age and E.S.N. schools (the last-named being Special Schools for the educationally sub-normal). It was to be expected that Modern and All Age schools would have mean scores much lower than Grammar and Technical schools, and very much higher than E.S.N. schools. There would be smaller differences between Modern and All Age schools on the one hand, and between Grammar and Technical schools on the other. It would therefore be advantageous to use "Type of School" as a second-stage stratification. On the other hand if this were done it would be impossible to adhere very closely to the principle of having a uniform overall sampling fraction (and thereby simplifying the computations and obtaining a neat analysis). A uniform overall sampling fraction would be obtained if the same number of schools were drawn from each area, and this number allotted to the different type in proportion to the size of the local strata. In making the draw this principle was followed as far as possible, but it was subject to two conditions, namely,

(*a*) each stratum actually found in an area should be represented in the sample by at least one school,

(*b*) subject to (*a*) very large sampling fractions should be avoided, on educational grounds.

Within each stratum selection was made, as at the first stage, with probability proportionate to size—i.e., number of pupils in the relevant age-group.

The application of these principles led to the following draw for the Urban stratum, and a similar draw for the Rural stratum:

Sampled Areas	*Sampled Schools Types*						*Pupils in the Age Group in Sampled Schools*
	Total	*G*	*T*	*M*	*A.A.*	*E.S.N.*	
1	10	4	1	4	1	0	221
2	11	1	1	4	4	1	205
3	6	2	1	3	0	0	171
4	8	2	1	3	1	1	151
5	11	2	1	6	1	1	201
6	11	2	1	6	1	1	206
7	11	2	1	6	1	1	240
8	11	2	1	6	1	1	246
9	6	2	0	3	1	0	128
10	11	3	1	5	1	1	212
11	11	2	2	5	1	1	197
12	10	2	1	6	1	0	202
Total	117	26	12	57	14	8	2,380

Where there is a zero in a "type" column it is because there is no school of the type in the area. There are no E.S.N. schools in areas 1, 3, 9, and 12. There is no All Age school in area 3 and no Technical school in area 9. Areas 3, 4, and 9 are compact areas with large schools, for which the number of schools in the sample has been reduced in accordance with condition (*b*) above.

Since it was impossible to preserve the principle of a uniform overall sampling fraction it was necessary to introduce weights in making the estimates of area means—these weights being proportional to the number of pupils in a stratum, and not to the number of pupils in sample schools. (This point is considered at length in the next section.)

In brief, then, the sample was a two-stage stratified sample, the sampling units at the first stage being L.E.A. areas, or subdivisions of L.E.A. areas, stratified into Urban and Rural. At the second stage the sampling units were schools within selected areas, stratified into the five types, namely Grammar, Technical, Modern, All Age and E.S.N. At each stage selection was made with probability proportionate to size. All pupils within the age-group in a selected school were included in the sample. The structure is shown graphically in the two diagrams. In Diagram 1 each g, t, m, a, represents a Grammar, Technical, Modern, or All Age school. (E.S.N. schools are omitted to save space.) The schools are arranged by column for L.E.A. area, and by row for

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

mean score in the test. This diagram, then, shows the *school* means. In Diagram 2 the G, T, M, A represent the *type* means, within areas. The X represent area means.

DIAGRAM 1

Score	Area 1	2	3	4	5	6	7	8	9	10	11	12
	–	–	–	–	–	–	–	–	–	–	–	–
32	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
31	–	–	–	–	–	–	–	–	–	–	–	*g*
	–	–	–	–	–	–	–	–	*g*	*g*	–	–
30	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	*g*	–	–	–	–	–	*g*	–	–
29	–	–	*g*	–	–	–	*g*	–	–	*g*	*g*	*g*
	–	–	–	–	*gg*	*g*	*g*	–	*g*	–	*g*	–
28	*g*	*g*	*gt*	–	–	–	–	*g*	–	–	–	–
	g	*t*	–	*g*	–	–	–	*g*	–	–	–	–
27	*g*	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	*t*	–	–
26	*g*	–	–	–	–	*g*	*t*	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	*t*	–
25	–	–	–	–	–	*t*	–	*mm*	–	–	–	*t*
	–	–	–	–	*tm*	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	–	
	t	–	–	–	–	–	–	–	–	*m*	–	
23	–	–	–	*t*	–	–	–	*t*	–	–	*t*	–
	–	–	–	–	–	–	–	*m*	–	–	–	–
22	–	–	*m*	–	–	–	–	–	*m*	–	–	–
	–	*aa*	*m*	–	–	–	–	–	*m*	–	–	–
21	–	–	*m*	–	–	–	*m*	–	–	*m*	–	–
	–	*m*	–	*m*	–	*m*	*a*	–	*m*	–	–	–
20	–	*m*	–	–	–	*m*	*m*	–	–	*mm*	–	*m*
	–	*a*	–	–	*a*	*m*	–	–	–	–	–	–
19	–	–	–	*m*	*m*	–	*mmm*	–	–	–	–	–
	mm	–	–	–	–	*m*	–	*a*	–	*a*	*m*	*m*
18	*m*	–	–	–	*mm*	–	–	–	–	–	–	–
	m	–	–	–	–	*m*	*m*	–	–	–	–	–
17	–	*a*	–	–	–	–	–	–	–	*m*	*m*	*m*
	a	*m*	–	–	*m*	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	*m*	*m*	–	–	–	–	*a*	*mma*
15	–	–	–	*ma*	–	–	–	–	–	–	*m*	–
	–	*m*	–	–	–	–	–	*m*	–	–	*m*	–
14	–	–	–	–	–	–	–	*m*	–	–	–	*m*
	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	*a*	–	–	*a*	–	–	–
	–	–	–	–	–	–	–	*m*	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	*m*	–
	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–

By themselves the diagrams might be misleading. They need to be considered in conjunction with the rules for estimating which follow from the method of drawing the sample. These rules are:

(1) *Second stage:*

Within Second stage strata . A simple average of the school means (or proportions) gives each stratum mean.

Area mean . . . . A weighted average of the strata means gives the area mean. The appropriate weights are proportional to the numbers of pupils in the local strata, and not to the numbers of pupils in the sampled schools.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

DIAGRAM 2

Score	Area 1	2	3	4	5	6	7	8	9	10	11	12
	–	–	–	–	–	–	–	–	–	–	–	–
32	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
31	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–	–	–	*G*
	–	–	–	–	–	–	–	–	*G*	*G*	–	–
29	–	–	–	–	–	–	–	–	–	–	*G*	–
	–	–	*G*	*G*	*G*	–	*G*	–	–	–	–	–
28	–	*G*	*T*	–	–	–	–	*G*	–	–	–	–
	–	*T*	–	–	–	–	–	–	–	–	–	–
27	*G*	–	–	–	–	*G*	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	*T*	–	–
26	–	–	–	–	–	–	*T*	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	*T*	–	–	–	–	–	*T*
	–	–	*X*	–	*T*	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–	–	–	*T*	–
	–	–	–	–	–	–	–	–	–	–	–	–
23	*T*	–	–	*T*	–	–	–	*T*	*X*	*X*	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	*X*	–	–	–	–	–
	X	–	–	–	–	–	–	–	–	–	–	–
21	–	–	*M*	–	*X*	–	–	–	*M*	–	–	–
	–	*AX*	–	*X*	–	–	*A*	*X*	–	*M*	–	–
20	–	–	–	–	–	–	–	–	–	–	*X*	*X*
	–	–	–	–	*A*	*X*	–	–	–	–	–	–
19	–	–	–	–	–	–	*M*	*M*	–	–	–	–
	–	–	–	–	*M*	*M*	–	*A*	–	*A*	–	–
18	*M*	–	–	*M*	–	–	–	–	–	–	–	–
	–	*M*	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–
	A	–	–	–	–	–	–	–	–	–	–	*M*
16	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	*MA*	*A*
15	–	–	–	*A*	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	*A*	–	–	*A*	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–

(2) *First stage:*

(i) A simple average of the area means gives each (first stage) stratum mean.
(ii) A weighted average of the strata means gives the estimate of the population value.

The reasons for these rules are given in the next section.

IV. ESTIMATING THE POPULATION MEAN AND ITS SAMPLING ERROR

It is now necessary to consider the sampling fractions and the raising factors in order to see how the estimates should be made. I shall use the following notation, and the reader should bear in mind that "Number of Pupils" always means "Number of Pupils in the relevant Age-Group":

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

N, Total number of pupils in a first-stage stratum.
N_i, Total number of pupils in the ith area.
T, Number of areas in the stratum.
t, Number of areas selected.
M_i, Number of Modern schools in the ith area.
m_i, Number of Modern schools selected in the ith area.
w_{im}, Ratio of the number of Modern school pupils in the ith area to the total number of pupils in that area.
n_{imk}, Number of pupils in the kth Modern school of the ith area.
$\bar{y}_{imk}$, Mean value per pupil of the variate for the kth Modern school.
$n_{imk}\,\bar{y}_{imk}$, Total value of the variate for the kth Modern school.

g, t, a, e and G, T, A, E play the same part for Grammar, Technical, All Age and E.S.N. schools as m and M for Modern schools.

By definition $w_{ig} + w_{it} + w_{im} + w_{ia} + w_{ie} = 1$.

Since selection is always made with probability proportional to size (i.e., number of pupils) the chance that the ith area is selected is

$$\frac{t}{T}\frac{N_i}{\bar{N}_i} = \frac{t\,N_i}{N} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

If the ith area has been selected at the first stage the chance of selecting the kth Modern school in it at the second stage is

$$\frac{m_i}{M_i} \times \frac{n_{imk}}{\bar{n}_{imk}} = \frac{m_i\,n_{imk}}{w_{im}\,N_i}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2$$

since $M_i\,\bar{n}_{imk} = w_{im}\,N_i =$ the number of Modern school pupils in the ith area . . . (3)

Consequently the initial chance of selecting the kth Modern school in the ith area is

$$\frac{t\,N_i}{N} \times \frac{m_i\,n_{imk}}{w_{im}\,N_i} = \frac{t\,m_i}{N\,w_{im}}\,n_{imk} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This is the sampling fraction, and the raising factor is its reciprocal, namely:

$$\frac{N\,w_{im}}{t\,m_i\,n_{imk}}.$$

Applying this to the total value of the variate for the kth Modern school we have, as the raised contribution from that school,

$$\frac{N\,w_{im}}{t\,m_i\,n_{imk}}\,n_{imk}\,\bar{y}_{imk} = \frac{N\,w_{im}}{t\,m_i}\,\bar{y}_{imk}. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The total Modern school contribution from the ith area is therefore

$$\frac{N\,w_{im}}{t\,m_i}\sum_{k=1}^{m_i}(\bar{y}_{imk}) = \frac{N}{t}\,w_{im}\,\bar{y}_{im}, \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$\text{where } \bar{y}_{im} = \sum_{k=1}^{m_i}\frac{1}{m_i}\,\bar{y}_{imk}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Corresponding to the right hand side of (6) we have similar contributions from the Grammar, Technical, All Age and E.S.N. schools in the ith area, so that its total contribution is

$$\frac{N}{t}\,\bar{y}_i = \frac{N}{t}\,[w_{ig}\,\bar{y}_{ig} + w_{it}\,\bar{y}_{it} + w_{im}\,\bar{y}_{im} + w_{ia}\,\bar{y}_{ia} + w_{ie}\,\bar{y}_{ie}] \quad . \quad . \quad (8)$$

Finally the stratum total is

$$\sum_{i=1}^{t}\frac{N}{t}\,\bar{y}_i = N\,\bar{y}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where $\bar{y}$ is the stratum mean.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The $\bar{y}_{imk}$ etc., are exact values, since every pupil in the selected schools is tested. The $\bar{y}_{im}$ etc., introduced in (6) and (7) are estimates, since not all Modern schools, but only some, in the ith area are included. The $\bar{y}_{im}$ are therefore subject to second-stage sampling variance, but this variance, as will be seen, is included in the estimate of first-stage variance. It is desirable to keep the $\frac{w_{im}}{m_i}$ etc., constant from area to area, but this is not always practicable since we must take the areas as we find them. Minor departures from this rule are not likely to have any serious effects on the estimate of first-stage sampling variance.

The first-stage variance can now be estimated in two ways. If we revert to (8) and (9), and drop the N—i.e., consider the stratum mean instead of the stratum total—we can set out the wy in rows and columns, thus:

TABLE A

Area	*G*	*T*	*M*	*A*	*E*	*Total*	
1	$w_{1g}\bar{y}_{1g}$	$w_{1t}\bar{y}_{1t}$	$w_{1m}\bar{y}_{1m}$	$w_{1a}\bar{y}_{1a}$	$w_{1e}\bar{y}_{1e}$	$\bar{y}_1$	
2							
3							
4	etc.	etc.	etc.	etc.	etc.	etc.	
i	$w_{ig}\bar{y}_{ig}$	$w_{it}\bar{y}_{it}$	$w_{im}\bar{y}_{im}$	$w_{ia}\bar{y}_{ia}$	$w_{ie}\bar{y}_{ie}$	$\bar{y}_i$	
	etc.	etc.	etc.	etc.	etc.	etc.	
t	$w_{tg}\bar{y}_{tg}$	$w_{tt}\bar{y}_{tt}$	$w_{tm}\bar{y}_{tm}$	$w_{ta}\bar{y}_{ta}$	$w_{te}\bar{y}_{te}$	$\bar{y}_t$	
Total	$Sw_{ig}\bar{y}_{ig}$	$Sw_{it}\bar{y}_{it}$	$Sw_{im}\bar{y}_{im}$	$Sw_{ia}\bar{y}_{ia}$	$Sw_{ie}\bar{y}_{ie}$	$S\bar{y}_i$	A
$\frac{Swy}{Sw}$	$\bar{y}_{gw}$	$\bar{y}_{tw}$	$\bar{y}_{mw}$	$\bar{y}_{aw}$	$\bar{y}_{ew}$	$\bar{y}$	B
$Sw^2_{ig}(\bar{y}_{ig}-\bar{y}_{gw})^2$ etc.	Q_g	Q_t	Q_m	Q_a	Q_e	Q	C

If we consider the row totals $\bar{y}_i$, i.e., the area means, we can estimate the variance of the stratum mean $\bar{y}$ as

$$\frac{Q}{t\,(t-1)},$$

where

$$Q = S(\bar{y}_i - \bar{y})^2.$$

This estimate takes into account the fact that the $\frac{1}{t}\sum_{i=1}^{t} w_{ig}$ etc., are sample estimates of the proportions of Grammar, Technical, etc., pupils. But since we know the population proportions we can use them as supplementary information to improve the estimate of the stratum mean, and if we do this we can reduce the estimate of its variance by using the Q_g, Q_t, etc. For if instead of looking at the rows we now look at the columns we see that each column yields a weighted mean, like $\bar{y}_{gw}$, whose variance is

$$\frac{t}{t-1}\,\frac{Q_g}{(Sw_{ig})^2}, \text{ where } Q_g = \sum_{i=1}^{t} w^2_{ig}\,(\bar{y}_{ig}-\bar{y}_{gw})^2.$$

These are the variances of the means for types of school, but they can also be used, along with the appropriate covariances, for estimating the variance of the stratum mean when the sample estimates of the proportions of types of school in the stratum are replaced by the population values. The tedious business of calculating the covariances can, however, be avoided by writing down row deviations $\bar{y}''_i$, where

$$\bar{y}''_i = \bar{y}_i - \bar{y}'_i \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

and

$$\bar{y}'_i = w_{ig}\bar{y}_{gw} + w_{it}\bar{y}_{tw} + w_{im}\bar{y}_{mw} + w_{ia}\bar{y}_{aw} + w_{ie}\bar{y}_{ew}, \quad . \quad . \quad . \quad (11)$$

and then forming $Q'' = S(\bar{y}''_i)^2$ which leads to $\frac{Q''}{t\,(t-1)}$ as the estimate of the variance of the adjusted stratum mean when use is made of the supplementary information.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

To illustrate the use of the notation I give below various tables relating to the reading test in the urban stratum. Table 1 gives the w_{im}, etc., as defined above—the type weights within areas.

TABLE 1

(*Weights, w*)

This table gives, for each of the 12 urban areas, the proportion of pupils in the age group in the various types of school—i.e., in all schools of the type, not merely in the schools in the sample.

	Area	*Weight*					*Total*
		w_{ig}	w_{it}	w_{im}	w_{ia}	w_{ie}	
	1	371	045	458	126	000	1,000
	2	168	043	412	365	012	1,000
	3	275	144	581	000	000	1,000
	4	252	012	656	070	010	1,000
	5	205	064	715	015	001	1,000
	6	151	027	760	060	002	1,000
	7	283	020	663	020	006	1,000
	8	194	055	696	043	012	1,000
	9	275	000	678	047	000	1,000
	10	305	038	612	043	002	1,000
	11	268	161	526	026	019	1,000
	12	232	065	583	120	000	1,000
A	Total	2,979	674	7,340	943	064	12,000
B	Mean per cent.	24·82	5·61	61·16	7·85	0·54	100
C	$\frac{s^2}{t}$	3·205	2·026	9·195	7·992	0·034	
D	$\frac{s}{\sqrt{t}}$	1·79	1·42	3·02	2·82	0·185	
E	Population proportions per cent.	23·31	5·46	58·41	12·23	0·59	

Decimal points are omitted from the body of the table. The row B at the foot gives the sample mean, which may be compared with the population mean in row E. Row C gives the sampling variance, and row D the corresponding sampling error. The differences between the sample and population values—the actual errors—are all less than the corresponding sampling error, except for the All Age class, where the actual error is one-and-a-half times the sampling error. The corresponding adjustments are made in Table 4.

Table 2 gives the corresponding $\bar{y}_{im}$, etc. The column means in row B of this table are included for comparison with the weighted means in row C of Table 3. They do not play any part in subsequent calculations. They are practically the same as the weighted means except for the All Age type, where the unweighted mean is 17·14 and the weighted mean 17·99. The cause of this discrepancy is clearly the fact that area 2 has both an unusually high proportion of All Age schools and an unusually high score for the type.

In Table 3 the weights, w, of Table 1 and the scores, $\bar{y}$ of Table 2 are married to give the weighted scores $w\bar{y}$. The row totals in this table are the area scores. The column totals (in row A) when divided by the summed weights (in row B, which is row A of Table 1) give the weighted means in row C. In row D the Q are formed as in Table A. The entries in row E are the squares of those in row B. Row F gives the variances of the $\bar{y}_w$ in row C, and row G the corresponding sampling errors.

The "Total" column in Table 3 can be regarded as a special case of the general column, in which all the weights are unity. Similarly, Table 1 can be regarded as a special case of Table 3, in which the weights are all unity and the w play the part of the y. This is how we must look

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

(*Scores*, $\bar{y}$)

This table gives, for each of the 12 urban areas, the mean score for each type of school. Scores are multiplied by ten to save printing decimal points.

	Area	*Scores*				
		$\bar{y}_{ig}$	$\bar{y}_{it}$	$\bar{y}_{im}$	$\bar{y}_{ia}$	$\bar{y}_{io}$
	1	273	237	184	168	—
	2	284	278	179	207	059
	3	287	283	216	—	—
	4	288	234	183	150	038
	5	286	248	187	198	010
	6	275	253	188	130	067
	7	290	261	195	209	027
	8	280	231	191	185	020
	9	298	—	215	134	—
	10	298	267	205	189	010
	11	291	244	156	156	073
	12	301	251	169	159	—
A	Total	3,451	2,787	2,268	1,885	304
B	Mean	28·78	25·34	18·90	17·14	3·38

TABLE 3

(*Weighted Scores*, wy)

This table gives, for each of the 12 urban areas, the weighted mean score for each type of school—i.e., the product of the corresponding entries in Tables 1 and 2. The row total is the estimate of the mean score for the area.

	Area	*Weighted Scores*					*Total*
		$w_{ig}\bar{y}_{ig}$	$w_{it}\bar{y}_{it}$	$w_{im}\bar{y}_{im}$	$w_{ia}\bar{y}_{ia}$	$w_{io}\bar{y}_{io}$	$\bar{y}_i$
	1	10·12	1·06	8·43	2·12	0·00	21·73
	2	4·77	1·19	7·37	7·56	0·07	20·96
	3	7·89	4·08	12·55	0·00	0·00	24·52
	4	7·26	0·28	12·00	1·05	0·04	20·63
	5	5·86	1·59	13·37	0·30	0·00	21·12
	6	4·15	0·68	14·29	0·78	0·01	19·91
	7	8·21	0·52	12·93	0·59	0·02	22·27
	8	5·43	1·27	13·29	0·80	0·02	20·81
	9	8·20	0·00	14·58	0·63	0·00	23·41
	10	9·09	1·01	12·55	0·81	0·00	23·46
	11	7·80	3·93	8·21	0·41	0·14	20·49
	12	6·98	1·63	9·85	1·91	0·00	20·37
A	Swy	85·76	17·24	139·42	16·96	0·30	259·68
B	Sw	2·979	0·674	7·340	0·943	0·064	12·000
C	$\bar{y}_w = \frac{Swy}{Sw}$	28·79	25·58	18·99	17·99	4·69	21·64
D	$Q = Sw^2(\bar{y}_{ig} - \bar{y}_w)^2$, etc.	0·6611	0·2380	11·457	1·2627	0·00045	23·83
E	$(Sw)^2$	8·874	0·4543	53·88	0·8892	0·0041	144
F	$\frac{t}{t-1}\ \frac{Q}{(Sw)^2}$	0·08128	0·5715	0·2320	1·5493	0·1198	0·1805
G	$\sqrt{\frac{t}{t-1}\ \frac{Q}{(Sw)^2}}$	±0·285	±0·756	±0·482	±1·245	±0·346	±0·425

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

at it to get the sampling variance of the weights. We could equally well look at it as a special case in which the w remain w, but all the y are one. In this case all the Q are zero, as we should expect. Since these Q would be the sampling variances of the weights, when the weights are adjusted to their population values, they are ex hypothesi zero.

In Table 4 the $\bar{y}''_i$ are formed by writing down the successive columns of $w_{ig}\bar{y}_{gw}$, etc., as in (11), summing the rows to give $\bar{y}'_i$, and then writing the $\bar{y}''_i$ column from the fact that $\bar{y}''_i = \bar{y}_i - \bar{y}'_i$,

TABLE 4

Area	$w_{ig}\bar{y}_{gw}$	$w_{it}\bar{y}_{tw}$	$w_{im}\bar{y}_{mw}$	$w_{ia}\bar{y}_{aw}$	$w_{ie}\bar{y}_{ew}$	$\bar{y}'_i$	$\bar{y}''_i$
1	10·68	1·15	8·70	2·29	0·00	22·80	−1·07
2	4·84	1·10	7·82	6·57	0·06	20·39	+0·57
3	7·92	3·68	11·03	0·00	0·00	22·63	+1·89
4	7·26	0·31	12·46	1·26	0·05	21·34	−0·71
5	5·90	1·64	13·58	0·27	0·00	21·39	−0·27
6	4·35	0·69	14·43	1·08	0·01	20·56	−0·65
7	8·15	0·51	12·59	0·50	0·03	21·78	+0·49
8	5·59	1·41	13·22	0·77	0·06	21·05	−0·24
9	7·92	0·00	12·88	0·85	0·00	21·65	+1·76
10	8·78	0·97	11·62	0·77	0·01	22·15	+1·31
11	7·72	4·12	9·99	0·47	0·09	22·39	−1·90
12	6·68	1·66	11·07	2·16	0·00	21·57	−1·20

$$Q'' = S(\bar{y}''_i)^2 = 16{\cdot}2028$$

$$\frac{Q''}{11 \times 12} = 0{\cdot}1227 = {\cdot}350^2$$

as in (10), the $\bar{y}_i$ being the last column of Table 3. We then form $Q'' = S(\bar{y}''_i)^2$ in order to get $Q''/t(t-1)$, which is the sampling variance of the stratum mean when the weights are adjusted to the population proportions.

This adjustment is made in Table 5, thus:—

TABLE 5

Adjustment of the mean by the use of the supplementary information about the population proportions

Type of School	*A* $B \times C$	*B* *Population Proportion (per cent.)*	*C* *Mean Score for Type*	*D* *Sample Proportion (per cent.)*	*E* $C \times D$
G	6·71	23·31	28·79	24·82	7·15
T	1·39	5·46	25·58	5·61	1·44
M	11·09	58·41	18·99	61·16	11·61
A	2·20	12·23	17·99	7·85	1·41
E	0·03	0·59	4·69	0·54	0·03
Total	21·42	100		100	21·64
Sampling error	±0·35				±0·42

The sample contains a slight excess of Grammar school pupils, and a slight deficiency of pupils in Modern and All Age school, when these two types are taken together. The adjustment, therefore, is a small reduction of the mean, from 21·64 to 21·42.

The rather heavy defect in the All Age type is balanced to some extent by the excess in the Modern school type, since there is little difference in the mean scores for these two types. The sampling method is in fact slightly biased here. Selecting the areas with probability proportionate to size tends of course to give more of the larger areas, and therefore an excess of Modern and a defect of All Age schools, since on the whole reorganization has gone further in the larger areas.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

But this is not a serious matter, because (*a*) there is little difference in the mean score for the two types, and (*b*) even this very small effect is removed by using the population proportions as supplementary information. For some variates—e.g., proportions of teachers of particular kinds—there would be well-marked differences between the two type means, but even so the bias could be corrected by the use of the supplementary information.

The sampling error for the rural stratum turned out to be 0·60. The weights for the two strata are 89 per cent. and 11 per cent. The final sampling error is therefore

$$\sqrt{(\cdot 35^2 \times \cdot 89^2) + (\cdot 60^2 \times \cdot 11^2)} = \pm \cdot 319.$$

The standard deviation per pupil is about 7·5, so that the equivalent simple random sample would contain about 550 pupils, and involve visiting practically as many schools spread through nearly every area in the country.

V. The Second-stage Sampling Variance

The second-stage sampling variance is automatically included in the estimate of the first-stage variance, and does not, therefore, affect the main object—namely, the estimation of the national mean and its sampling error. It is, however, of some interest since it affords an indication of the extent to which the differences in the estimates for areas reflect real differences between those areas. I say "between those areas" advisedly, because we know quite well, on other grounds, that in general area differences do exist, although insufficient importance is sometimes attached to this point in calculating test norms, and in calibrating one test against another.

The raised contribution from a particular school was shown in equation (5) above to be

$$\frac{Nw_{im}}{tm_i}\,\bar{y}_{imk}.$$

In this expression N/t is constant throughout the sample, and it would have been highly convenient for the computations, and would have enabled a more elegant analysis to have been made, had it been possible to keep w_{im}/m_i, and the analogous expression in g, t, a, e, constant as well—that is, to have a uniform overall sampling fraction. Unfortunately, the distribution of schools among types in areas is not such as to render this practicable, though the principle was adhered to as far as possible in drawing the sample (see Section III), Since the sampling fraction is not uniform it is necessary, in a rigorous calculation of the second-stage variance, to have regard to the w_{im}, etc., and proceed by stages. If we write

$$s^2_{im} = \frac{\sum_{k=1}^{m_i} (\bar{y}_{imk} - \bar{y}_{im})^2}{(m_i - 1)}$$

we get, for the corresponding term in the variance,

$$\frac{w^2_{im}\,(1 - f_{im})\,s^2_{im}}{m_i}.$$

Along with this term for m_i are similar terms for g_i, t_i, a_i, and e_i, and if we sum these terms we get the second-stage sampling variance for the ith area, which we may call $s^2{}_i$. I think the sampling fractions, f_{im}, etc., ought to be included here, since the systematic method of selection precludes the same unit being selected twice. At any rate it is clear that the fraction must be included in those cases where its value is unity—which happens, for example, when there is only one Technical school in an area. Where the only school of a type in the area is the one included in the sample the corresponding variance is clearly zero. In other cases where there is only one school of a type in the sample (though there is more than one in the area) it seems reasonable to assume $s^2{}_{it} = s^2{}_{ia}$, and $s^2{}_{ia} = s^2{}_{im}$, in calculating $s^2{}_i$.

The values of the $s^2{}_i$ range from ·05 to 1·58, with an average of ·39. The range would be wider were it not for the fact that the largest $s^2{}_{mi}$ has a fairly large sampling fraction attached to it. Each particular $s^2{}_i$ is based on only a few degrees of freedom, and it therefore seems reasonable to take

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the pooled value of ·39, and its square root ±·6, as the best estimate of the internal sampling variance and error per area, which leads to ·39/12 and its square root ±·18 as the corresponding values for the whole stratum. A comparison between this and the estimate of the first-stage sampling error (±·35) makes it clear that the differences between the areas are greater than any which the second-stage sampling would account for. In the detailed consideration of the results (which cannot be pursued here) the particular, as well as the average, value for s^2_i is of interest.

VI. Qualitative Variates

In the preceding sections I have illustrated the method by using a variate, namely, a test score, which is quantitative for the individual pupil. The procedure is equally applicable to variates which are qualitative for the individual, since individuals who possess the attribute can be given the score 1, and other individuals the score zero. For example, it was of interest in the reading inquiry to know the proportions of pupils in cetrain mark ranges. The answer to the question "was this pupil's mark in the range 35–31?" is either "yes," in which case we can put $y = 1$ for him, or "no", in which case $y = 0$. Adding these scores for the school and dividing by the number of pupils in the school gives us $\bar{y}_{imk}$ as the score for the kth Modern school of the ith area, as before, and from this point onwards the calculations follow the same pattern.

The mark ranges, which happen to be of particular interest (for reasons into which I need not enter), are set out at the head of the following table, and the proportions of pupils in those ranges in each type of school are entered in the body of the table.

Table 6

Proportions of Pupils in Certain Mark Ranges

Type of School	*Mark Range*						*Total (per cent.)*
	35–31	30–23	22–18	17–9	8–3	2–0	
Grammar schools .	32·6 ± 3·3	63·9	3·5	0·1	0·0	0·0	100
Technical „ .	7·6 ± 2·2	73·5	15·5	3·4	0·0	0·0	100
Modern „ .	1·1 ± ·46	31·7	28·9	33·0	4·7	0·6 ± ·3	100
All Age „ .	1·1 ± ·44	27·0	24·3	41·3	3·1	3·1 ± 2·6	100
E.S.N. „ .	0·0	0·0	0·1	11·4	46·9	41·7 ± 14·1	100
All types . .	9·28 ± 1·25	41·47 ± 2·51	21·33 ± 1·00	23·72 ± 2·79	3·40 ± 0·56	0·81 ± 0·30	100
Adjusted . .	8·79 ± 1·03	40·70	21·52	24·61	3·43	0·97	100

The column entries in the above table correspond to the column totals in Table 3—that is, they are weighted means like $\bar{y}_w$ and have been calculated in exactly the same way. The sampling errors have been calculated like those in the last row of Table 3. The sampling errors in the last row but one (of Table 6) correspond to that in the last column of Table 3. In the "Adjusted" row of Table 6 the adjustment is the adjustment of the sample estimates of the type proportions to their population values. It is exactly analogous to the adjustment made in Table 5. It would be possible to calculate the sampling errors for the adjusted row in the same way as in Table 4, but since we know that they will be less than the corresponding estimates in the previous row they are not of great interest.

The general pattern of the proportions in the mark ranges is what would be expected; the Grammar schools and Technical schools have no pupils in the lower ranges, and the E.S.N. schools no pupils in the upper ranges. The pupils in Modern and All Age schools are concentrated in the middle ranges.

The sampling errors for the very small proportion in the last column are, of course, themselves subject to a high degree of sampling error, but this is inevitable under any system of taking a small sample. They provide good evidence that the proportion of the population in this class is exceedingly small, and this is as much as one can expect to get, without undertaking an inquiry on a very much larger scale. It is, however, of interest to look at the sampling errors when the last two

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

columns of Table 6 are combined. For these larger proportions the estimates of sampling error are more reliable.

TABLE 7

	Proportion in score range 8–0 (per cent.)
Modern schools . . .	5·3 ± 1·1
All Age schools . . .	6·2 ± 3·8
E.S.N. schools . . .	88·6 ± 7·6
All types	4·21 ± 0·7
Adjusted	4·40 ± 0·63

The sampling error in the last row has been calculated on the lines of Table 4.

VII. THE EFFICIENCY OF THE DESIGN

In considering the efficiency of a sampling design one has to keep two conflicting points in mind. On the one hand it is generally true that, when a given amount of material is included in the sample, the smaller the sampling units employed the more accurate and representative the results. Thus, from this standpoint, for a sample containing a given number of pupils it is better to take pupils as sampling units than to take schools, and better to take schools, in a single-stage sample, than to take areas as the first stage, and schools as the second stage, in a two-stage design. But the need for small units distributed over the whole aggregate may conflict with administrative requirements, and also with the need (if it exists) for having enough information about some sub-divisions of the aggregate, or domains of study. In the reading test inquiry the two-stage process was made necessary in the first place by administrative requirements. But the design also yielded information about differences between areas which would not have been given by a single-stage design.

Although neither of the single-stage designs would have satisfied the conditions of the problem, it is of some interest to make rough estimates of the numbers of pupils, or of schools, needed in the two cases. It has been shown above (Section IV) that if pupils are taken as the sampling units in a single-stage design about 550 would be needed to produce the same accuracy. This would have involved visiting practically as many schools.

It is more difficult to estimate the number of schools which would have been needed in a single-stage design, and the data are hardly adequate for an elaborate analysis. A scrutiny of Diagram 1 suggests that the standard deviation of school means, for Urban Modern schools, is of the order of three points. For All Age schools it is likely to be about the same. For Technical schools it will be less, and for Grammar schools not much over one point, but even allowing for this the reduction in the number of Urban schools needed if a single-stage design with schools as sampling units were used would not be very marked. Such a design would, of course, involve practically as many areas as schools, and it would give no information about differences between areas.

The disadvantage of a two-stage design is the reduction in the number of degrees of freedom on which the estimate of the mean ultimately rests. In this case there were only 17 first-stage units in the sample—12 Urban and 5 Rural areas. Seventeen is not a large number, but it is, I think, large enough to ensure a reasonably normal distribution of the sample mean, even though there is no reason to suppose that the area means are normally distributed. Unless the distribution of the area means is very highly skewed the means of quite small samples will be distributed with a close approximation to normality. The usual proof of the Central Limit theorem does not indicate the extreme rapidity of the convergence on normal distribution as sample size increases. Thus, if the throws of an ordinary die are scored at face value for 1, 2, and 3, and at zero for 4, 5, and 6, the exact sampling distribution for means of ten throws does not differ at any point from the corresponding normal distribution by more than one half per cent., and while the distribution of area means may be quite skew, it will certainly not be as skew as this. Therefore although the number of areas is small, it is, I think, adequate.

The two-stage design has two merits. In the first place it is administratively convenient, since the schools to be visited are grouped in certain areas. In the second place it brings out clearly

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the existence of differences between areas, which is sufficiently obvious when one comes to think about it, but which nevertheless is frequently overlooked. For any aspect of school work there may well be differences in general level not merely between schools in different parts of the same town or county, but between towns and counties considered as aggregates, so that generalizations based on a purely localized inquiry may be misleading if applied outside that locality, no matter how much evidence was collected inside it. Stated thus baldly the point is indeed plain; it would be absurd to conclude that there were no black swans in the world because none had been observed on the Thames. But though its naked form is unattractive, the error is capable of assuming some insidious disguises. For example, test norms are sometimes given, complete with probable or standard errors obtained by dividing the variance by the number of pupils in the trial, in disregard of the fact that these pupils were all concentrated in a few schools in a single area. In such a case there is no reason to suppose that the norm is representative of a wider area, and even for the area in question the estimate of sampling error would be too small, were it not for the fact that the sampling fraction may also be ignored, and usually is. It would not, of course, be practicable as a rule to obtain a really representative sample of the whole country for the purpose of standardizing a test. Nor is it necessary to do so. The main object of a test is, as a rule, to put pupils in an order, and accurate norms are not essential for this purpose. None the less, the publication of norms which purport to be representative of the whole country, but are actually very far from being so, leads to a certain amount of confusion and misunderstanding. When the published norms of two tests are shown to be incompatible the tests themselves tend to be discredited, despite the fact that they may answer their real purpose quite well.

Although the initial sampling for standardizing a test cannot, in general, be sufficiently widespread for it to be said that the norms are representative of the whole country, yet none the less if in practice the test is used over many L.E.A. areas a body of results will gradually be accumulated which may provide quite satisfactory evidence for a national norm. There is no reason to doubt the validity of the norms attached to tests which have been used on a very wide scale. But before a norm can be said to be representative of the whole country, either a rigorous sampling scheme, or use on a very wide scale, with correction for such obvious sources of bias as the difference between Rural and Urban districts, is needed.

VIII. Another Inquiry, with a Further Source of Variance

The reading test was an example of what is called an objective test—that is to say the process of dealing with it consists in underlining one of a number of alternatives for every question, one of these alternatives being deemed, in each case, to be right, and the remainder wrong. The method of constructing such a test is both elaborate and well known; at any rate it will not be described here. The advantage is that once the test has been constructed the marking is mechanical, and, if conducted with reasonable care, invariant. The act of judgment (of relevance to the purpose in hand) occurs in the construction and not in the marking of the test. The disadvantage—at any rate the disadvantage that would attend an increasingly widespread use of such tests—is that they sample only a limited part of a pupil's powers, and that while in a given school at a given time they correlate high with tests of these other powers, yet none the less their extended use might lead to the gradual hypertrophy of the one side and the atrophy of the other. The correlations would still remain high—just as English and French correlate high in English grammar schools and French lycées alike, though in each case the command of the native tongue is at a far higher level. Although this is an extreme example it does, I think, serve to bring out an essential point that is often overlooked in the arguments about the merits and demerits of objective tests. It makes it plain that high correlation within schools may be attended by low correlation between schools, and that a continued high correlation is quite compatible with divergence in average standards.

In order to get some light on the extent to which standards do at present differ between schools in two fairly closely related aspects of school work, it was decided to ask each pupil who dealt with the reading test to produce a piece of written composition* as well. This introduced a new

* I should perhaps remark at this point that although those concerned with education hold many different views about the kind of writing which children may most profitably undertake, all would agree that it should at any rate be varied; as with food, a mixed diet is best. It would be a mistake to erect any particular subject, or kind of subject, as a proclaimed standard of "composition ability".

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

complication into the statistical work—the problem of classifying the compositions. Whereas, with the objective test, an act of judgment (of relevance to the purpose in hand) occurs only in the construction of the test, with compositions, and indeed with any examination of the usual type, acts of judgment occur not only in the setting but also in the marking. It is sometimes thought that it follows from this that the total of irrelevance must necessarily be greater, but this is plainly an error. It may be or it may not. An elastic tape may give a better measure of stature than a very good weighing machine, because the error arising from the imperfect correlation between weight and stature may be greater than the error caused by an extremely imperfect tape. And if several tapes are available there is something* to be said for taking the average of their statements as the best measure to hand, having first adopted such rules for the conduct of the measurement as seem reasonable, practicable and convenient.

From time to time various more or less elaborate rules have been proposed for the conduct of markers in the business of classifying children's compositions. On the whole, however, experience shows that such rules fail in their intended effect: the degree of consistency (or inconsistency) between experienced markers remains much the same as before—only the more elaborate the rules the longer they take to apply. The same sort of thing appears to hold in the writing of reports on personal qualities in pupils, or on the staff in a large department in industry or the civil service. Despite the plain fact that in all such cases the thing reported on has many dimensions, more consistent results are often obtained by treating it as one dimensional and sorting into no more than a few classes (such as Very good, Good, Middling, Fair, and Poor).

On the particular question of marking essays it is admittedly an advantage for all markers to have at hand a set of "typical" essays, each member being thought to be representative of one of the classes into which the sort is to be made. This limits (but does not abolish) the differences in standard between different markers, or between the same markers' standards at different times. The latter is quite considerable, and arises, or so it seems to me, from the limited span of one's attention. In dealing with a set of papers all before one during the same fairly short interval one can be more consistent than when attention is spread over days, or even over morning and afternoon.

It seemed to me that if the aid of a fairly large number of experienced teachers could be enlisted it would be possible to organize the markings in such a way that the effects of individual differences of opinion would not only cancel out, but could be shown to cancel out, to a large extent, in the estimates of the mean: in other words, to organize things in such a way that the marking error made only a small contribution to the total sampling error.

* Something to be said: perhaps less than some suppose, and more than others. To some minds there is something essentially abhorrent in the resort to arithmetical processes, such as averaging, in these matters. In others the arithmetic is given more weight than it will really bear, as if a man should tread on a snow-bridge in ignorance of the gulf beneath. To those who adopt a middle position it seems that this divergence of view arises from the same cause on each side—namely the supposition that a number is intended as a statement of fact when it is really meant to be a statement of probability. Such a middleman would readily admit that a large penumbra of doubt inevitably attends the assessment of school work, irrespective of the particular form of the assessment, and that the mind hot for certainties can get no more than a dusty answer. To his left-hand neighbour he might add that neither seven maids with seven mops nor seven doctors of philosophy with seven objective tests can sweep the dust away. To his right he might murmur that an opinion remains an opinion even when expressed by a Greek letter, and that a decision is a decision though wholly uncontaminated by arithmetic. To the one side he would commend the words of Lady Macbeth—"All the perfumes of Arabia cannot sweeten this little hand"—and to the other those of Sir Richard Grenville—"Dost thou not see, fellow, that thou hast sworn a ten times greater oath than ever I should have asked of thee?" To put the thing another way, any process of measurement consists essentially in attaching numbers to classes according to rules, and the process of attaching numbers does not in itself imply either a greater or a less degree of uncertainty about the classification. There may be such implications in what is subsequently done with the numbers, but so there may in what is subsequently done when the classes are left unnumbered. In either case the subsequent steps may or may not be justified. An I.Q. has a fairly large probable error: on the other hand:

> "Twixt Right and Wrong the difference is dim.
> 'Tis settled by the Moderator's whim.
> Perchance the Delta on your paper marked
> Means that his lunch has disagreed with him."

(*V. infra*—Section X—for such a post-prandial effect!)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

"To vouch this is no proof,
Without more certain and more overt facts
Than these thin habits and poor likelihoods
Of modern seeming do prefer."

as the Duke* remarks in "Othello", but I give some supporting facts below.

IX. Pooling Opinions

I was fortunate in being able to enlist the aid of about a hundred experienced teachers at one of the Ministry's Short Courses. Of these volunteers 69 acted as markers and the remainder as recorders and computers. Through their help, and with some careful preliminary organization, it proved possible to carry out the whole task in a day. The preliminary organization took this form. The scripts from each area were called a set, and each set was divided into four or five batches by dealing the scripts from each school into the batches (as cards are dealt into hands) until they were exhausted. Each script had a code number, and for each set a working sheet was prepared carrying the code numbers of the scripts arranged in columns for batches and rows or blocks of rows for schools. Duplicates of each sheet were divided into columns, or strips. One copy of each strip was pasted to the envelope containing the corresponding batch, and two copies were enclosed for the use of markers. The sheets themselves were for the use of the recorders.

On the day of the marking each batch was marked by one teacher in the morning session, and by another in the afternoon. The morning marks are hereafter called X, and the afternoon marks Y. The markers who dealt with one set are called a team. The process of marking consisted of sorting the scripts into seven classes, defined by a set of "typical" compositions, of which each marker was given a copy. The "marks" consisted of the class numbers and therefore ranged from 0 to 6. After sorting each marker entered the class numbers against the code numbers on his strip, and handed the strip to the pair of recorders assigned to his team. The recorders had to transfer the marks from the strips to the sheets, entering X and Y on separate sheets, and then find the school totals and means. They also made frequency groups for pupils which enabled a

* This most celebrated of the Dukes of Venice deserves, I venture to think, the posthumous homage of this Society, which must heartily approve his opinion on who was fitted to bear the highest offices of state:

"'Certes, says he,
I have already chose my officer'
And what was he?
Forsooth, a *great arithmetician*,
One Michael Cassio, a Florentine."
—*Othello*, Act I, scene (i).

As might be supposed of one who held such enlightened views his ideas on probability and statistical estimation were far in advance of those generally entertained by eminent men in his time, and indeed in our own. Witness Act I, scene (iii):

Duke: There is no composition in these news
That gives them credit.
First Senator: Indeed they are disproportioned.
My letters say a hundred and seven galleys.
Duke: And mine, a hundred and fifty.
Second Senator: And mine, two hundred.
But though they jump not to a just account
As in these cases, where the aim reports,
'Tis oft with difference—Yet they do all confirm
A Turkish fleet, and bearing up to Cyprus.
Duke: Nay, it is possible enough to judgment:
I do not so secure me in the error
But the main article I do approve.

We can only applaud the sound statistical insight shown throughout this passage, and particularly in the last two lines. At the same time we must regretfully admit that the envious Iago's "Forsooth" still echoes loudly in the public ear.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

first check on the consistency of the marking to be made by calculating the crude correlation for X and Y. (It was 0·72.) This stage was reached by the late afternoon, although there were 3,266 scripts in all, through the excellent team work of the volunteers. The remaining computations were completed by midnight.

Each marker was left quite free to use his judgment as he thought best in putting the scripts into the classes roughly defined by the "typical" compositions, and the afternoon mark was given, by a different person, in ignorance of the morning mark.

It will be seen that the effect of these arrangements was that each pupil, school, area, and the whole sample received an X and Y, and that for both X and Y

(*a*) each pupil's mark represented a single opinion;
(*b*) each school, and each area, mean represented the pooled opinions of a team;
(*c*) the sample mean represented the pooled opinion of all the teams.

X. THE MARKING AND SAMPLING ERRORS

The discrepancies between the X and the Y marks can now be considered under three heads:
(*a*) The mean value of $X - Y$ estimated from the whole sample.
(*b*) The first stage sampling variance of $X - Y$.
(*c*) The second stage sampling variance of $X - Y$.

On the whole the markers became somewhat harder hearted as the day wore on. This swing from lenity to severity is represented by (*a*). But not all teams were affected by this general stiffening to the same degree; these variations are represented by (*b*). And finally, when for a given pair of teams the mean team and time variation has been eliminated there remains random variations in school means which are represented by (*c*).

The actual values of (*a*), (*b*) and (*c*) are shown below. In order to make the marks easily comparable with those of the reading test they were scaled up by multiplying by 100/3. When this had been done the final values, for the whole sample, were—

	$X + Y$	$X - Y$	
Mean	214	4·2	(*a*)
First stage sampling error	±3·6	±1·5	(*b*)
Second stage sampling error	±3·3	±0·7	(*c*)

The middle row is computed by taking the variance between areas, and the bottom row from the variance of school means within areas. The fact that (*b*) is larger than (*c*) shows that teams differed somewhat in severity even at the same time, as was to be expected. This cannot be overcome by having fewer teams, since fewer teams will need more time. But even the (*b*) variance is quite small—the variance ratio in the middle row is six to one, so that the marking variance (*b*) makes a contribution of only one-sixth to the final sampling variance, and has therefore a negligible effect on the size of the sampling error.

There remains the major or post-prandial discrepancy (*a*). After lunch the markers were in a more magisterial frame of mind than before. They awarded their marks less freely, and this is reflected in a mean difference of 4·2 between X and Y. This is very small in relation to the total spread of marks—from 0 to 400 on this scale—but none the less somewhat greater than the final sampling error of 3·6. There is no evidence as to whether it is an effect of lunch, or of weariness, or of practice, and on another occasion, with different markers and a different lunch, it might be either more or less. But since it is a mean difference between morning and afternoon, and since all scripts were marked on each occasion, it does not enter into any estimates of difference between pupils, schools, or areas. If statures are measured in the morning with boots on, and the same statures in the afternoon with boots off, the average thickness of boot heels does not enter into the comparisons, though the variance does (and we have already taken account of it under (*b*)).

Intermingled in the batches with the 1952 scripts were others from an earlier epoch (1949), bearing no distinguishing marks. The comparison for the two years was—

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	$C(=X+Y)$	$X-Y$	*Sampling Error of C*
1952	214	4·2	±3·6
1949	192	2·8	±6·0 ?
1952–1949	22	1·4	±7

[The 1949 sample was selected deliberately, so that its sampling error is unknown, but a comparison with the (larger) 1952 sample suggests that the sampling error would be of the order of 6.]

The 1949 and the 1952 scripts were both marked on each occasion, and the 4·2 and the 2·8 in the $X-Y$ column are both estimates of the mean post-prandial effort, and their difference of 1·4 is satisfactorily small in comparison with the estimate of the difference in $X+Y$, namely 22, and its sampling error of ± 7. (It is also easily compatible with the second stage sampling error of $X-Y$ when the smaller size of the 1949 sample is taken into account.)

The estimated gain between 1949 and 1952 is slightly reduced, from 22 to 20, if the supplementary information about the population proportions is used as in Tables 5, and the sampling error is simultaneously reduced from 3·6 to 3·3. The gain is quite considerable. It is about a quarter of the estimated standard deviation for all pupils, and when converted to an age scale is equivalent to about six months of progress by a middling pupil. The estimates of sampling error, for the 1952 sample, are very much the same as for the reading test. The equivalent simple sample of pupils is about 500, without the supplementary information, and about 600 when the supplementary information is used.

XI. Comparison of the Results of the Two Tests

If the reading test marks are multiplied by ten their mean and variation happen to be practically the same as those for the composition marks. This enables a comparison to be made between the results. Thus for the urban areas we have—

Composition (C) and Reading (R) Scores

Area	$C(=X+Y)$	R	$C+R$	$C-R$	$X-Y$
1	240	217	457	+ 23	− 1
2	214	210	424	+ 4	11
3	231	245	476	− 14	− 5
4	214	206	420	+ 8	14
5	190	211	401	− 21	12
6	226	199	425	+ 27	5
7	236	222	458	+ 14	11
8	206	209	415	− 3	1
9	212	234	446	− 22	3
10	220	235	455	− 15	1
11	210	205	415	+ 5	5
12	216	204	420	+ 12	1
Mean	218	216	434	2	5
Sampling error	± 4·0	± 4·2	± 6·5	± 4·8	± 1·7

It will be seen that, although the areas are represented by the same schools in each case, the correlation between area means for C and R is quite low. It is in fact 0·29. The correlation between pupils, on the other hand, is quite high (0·72). The variance in the $C-R$ column is about eight times that in the $X-Y$ column, which shows that variations in marking cannot account for the low correlation between the area means for the two tests. This illustrates the point made earlier about the many facets of school work, in all of which success depends not only on the ability of the pupil and the skill of the teacher, but also on the relative degrees of importance attached to the different facets in different schools. Within a school there is a fairly high correlation between different subjects, because success depends mainly on the general ability of the pupil. But between schools differences of stress in teaching and time-tables play a larger part, and the pupil's ability plays a smaller, since all schools contain a fairly wide range of ability among

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

their pupils. For the same sort of reason a calibration of two tests in a restricted area is inapplicable outside that area, as is shown by the size of the entries in the $C - R$ column.

The mean scores for types of school were very much the same as in Table 5. For the urban stratum they were 318 (G), 247 (T), 183 (M), 167 (A), and 19 (E.S.N.). The adjustment to take account of the supplementary information is made in the same way as in Tables 4 and 5.

XII. CONCLUSIONS

One learns by doing, "Experientia does it" as Mrs. Micawber's papa used to say. When I was first charged with the duty of planning these inquiries it was the difficulties of making satisfactory sampling arrangements which appeared most formidable to me. Simple sampling was obviously too expensive, and no other form of sampling giving proper estimates of the sampling error had been attempted in education. It now seems to me that on this side of the problem one can be on firm ground. The school population can be specified. We know, to a high degree of precision, where every member of it is, and of what larger unit—school or district—he forms part. These units, it is true, are somewhat untidy from the statistician's standpoint. Schools vary greatly in size and in kind, and sizes and kinds are disposed in very different numbers and proportions in different areas. None the less, if the arguments in this paper are correct, it is possible to draw a small sample which shall be administratively convenient and economical, and yet capable of yielding satisfactory estimates both of population means and of sampling errors. On such evidence one can then invoke the laws of pure mathematics, and say that either the population mean lies between such and such narrow limits, or an extravagantly improbable chance has occurred in the drawing of the sample. So far, so good. So long as one is content to regard the test score as a variable in its own right, like, say, stature, one is on firm ground. It is when one begins to consider it as a symbol of something else that the snow begins to feel loose.

In the course of carrying out the inquiries I was led to form rather clearer notions of certain traps, or idols in the Baconian sense, that beset all attempts to assess the value of the work of the schools. The three which are perhaps most interesting from the statistical standpoint I distinguish as the Black Swan, the Symbol, and the Cage. To the Black Swan I have referred above (Section VII). It is a form of the extrapolation fallacy.

The Symbol is the danger inherent in letting one thing stand for something else. It is not a danger that can be wholly avoided. Mountaineers are sometimes advised to eschew places where stones may fall. A mountaineer who took this advice literally would generally remain at the bottom of his peak, and the alternative to symbolism is sterility. But caution is needed. A score in a reading test is one thing, and "reading ability" is another. And both are aspects of a wider concept called "literacy", of which the assessment of a "composition" is another facet.

Now there is plenty of evidence that within a school (that is to say where pupils have the same teachers and the same time-tables) the various facets of literacy are highly correlated. It is clear, though it is sometimes overlooked, that a high correlation between schools (i.e., where teachers and time-tables are different) is not a necessary consequence of this, and in fact the correlation between schools in the two facets discussed in this paper turned out to be somewhat lower than I should have expected. This brings me to the third trap, namely—

The Cage.—We are all prisoners of our time. Fashions change, and we change with them. Only the bold man can be a nonconformist, and he must temper his boldness with prudence lest he be thought merely eccentric. Education is no more exempt than other arts from the tide of fashion, and the temptation to adopt the ideas of others, particularly if they are powerfully advocated, rather than hammer out one's own, is strong. Though it is perhaps less in this country than in others, the pressure to conformity is great and ought to be diminished, since, in modern schools at any rate, we are only at the very beginning of a process of evolution in which there is plenty of room for individuality. One of the forms of pressure—by no means the only one, nor the most powerful, but the one which happens to be most relevant here—is the development of the objective test. The original idea behind the objective test is wholly admirable. The purpose is to have a standard of assessment which shall be free from the fluctuations of opinion between different persons, and between the same person at different times—fluctuations which are exemplified in the X and Y of this paper.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Experiment with objective tests showed that they correlated well—within schools—with other assessments of school work. They were invariant in a way that other assessments were not, and, other things being equal, this makes them a more reliable method of assessment. Unfortunately there is no guarantee that other things will remain equal as the objective test gains ground, and there is some evidence that they will not. A test score may be a symbol of various things; among others it may be a symbol of success. We all like success, and we are all tempted to take short cuts towards it. Here the particular merit of the objective test—its invariance—becomes its greatest danger. The test tends to define the content of learning, and thereby to confine it within narrow channels. It is easy to construct an objective test of English vocabulary, or Latin grammar, or the multiplication table. It would be temerarious to attempt one of English composition, or Latin prose style, or mathematical insight, while for half the content of education it would, I surmise, be quite impossible. It seems likely, therefore, that a wide-spread development of objective testing would result in a somewhat greater accuracy of assessment of what was still learnt, at the expense of a progressive narrowing in the content of the thing assessed—a non-regenerative form of Heisenberg's principle, so to speak. This would be peculiarly unfortunate in the modern school, where one of the main tasks is to develop new forms, of content, of presentation, and of practice, and where there is room for a moderate amount of heterodoxy.

Accurate assessment is important. A pupil is entitled to a just and fair account of his achievement and promise. But the diameter of the cake is important, as well as the angle of the section, and it is the diameter of the cake that would be threatened by the growth of objective testing.

It is also important that in developing new values we should not lose the old, and it is here, perhaps, that the objective test can play a more useful part. If it is employed for sampling inquiries, at longish intervals, with a wide-spread and very low intensity of sampling, the danger that it will distort the content of a school's courses becomes negligible, since no school is at serious risk of being drawn in the sample, and even if drawn it remains anonymous. Used in this way an objective test retains the virtue of its invariance, and loses the black shadow that otherwise dogs it. It can yield useful information, which can then be interpreted in the light of other knowledge.

I have tried in this paper to illustrate the proposition that sampling can play a small but useful part in the progress of education provided certain dangers are avoided. The main towers defending this particular ridge I have called the Black Swan, the Symbol, and the Cage. The Black Swan can be overcome by a bold frontal attack in the form of a sound sampling method. The Symbol needs some rather cautious turning movements if one is not to get into a false position. On the third tower the rock is bad, and lightness of touch and a wide dispersal of weight are needed to avoid bringing it down. In other words, one must be careful to see that the sample really represents the specified population which it purports to represent, that the results are not misinterpreted (and, what is more difficult, not given to the public in a form which can easily be misunderstood), and that the process of inquiry is not itself harmful to education, through a heavy concentration in one area or at one time.

I thought it right to refer to the difficulties of interpretation, and the danger of concentration on a particular form of test, because both are germane to the subject matter of the inquiries I have used to illustrate the application of sampling methods. There is, of course, no reason why sampling methods should be confined to inquiries of this nature. Although the organization of our educational system is both complicated and irregular (and deliberately so, because we value freedom and experiment more than uniformity), we have ample information to enable single or multistage samples to be drawn for many purposes, each with an appropriate choice of sampling units and stratifications.

Discussion on Mr. Peaker's Paper

Mr. E. C. Fieller: When I was asked to propose the vote of thanks to Mr. Peaker, it occurred to me that in spite of the fundamental importance of education in the life of the community, and in spite of the large volume of statistical work that its administration must entail, our Society rarely received a paper describing work in this important field.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In 1935 Major Greenwood chose, as the topic of his Presidential Address, "The Recent History and Function of University Education", but apart from that, a hurried examination of our *Journal* over the last thirty-five years brought to light only one paper even remotely concerned with an educational topic. In March, 1922, Mr. J. Y. Hart reported on "An Investigation of Sickness Data of Public Elementary School Teachers in London, 1904–1919". I am not sure whether Mr. Peaker would have agreed in full detail with Mr. Hart's methods, because Mr. Hart worked on the records of a number of county electoral districts deliberately selected as representative, and rejected random sampling of these records, in favour of a complete examination, merely on the grounds that in any one year nearly half the teachers had no absence, and that full information as to age was not available. Mr. Peaker would, however, surely welcome Mr. Hart's conclusions and hope that they remain true: "it seems clear that school environment plays a comparatively small part in determining illness", and "teachers form a healthy class of the community".

Now that Mr. Peaker is telling us something of the work of his Ministry, we must all welcome the extent to which it reflects modern trends in statistical methodology—the acceptance, without question, of the sampling method rather than the full-scale inquiry as an appropriate administrative tool, the insistence on economy, in terms of cost per unit of information, as the criterion for choosing between rival sampling methods, and the calculation of the standard errors of the estimates obtained, in the light of the particular sampling method adopted. As far as I am aware, this is the first time that a rigorously devised multi-stage sampling scheme has been adopted for an educational investigation in this or any other country, and I am most glad that Mr. Peaker has given us the opportunity to hear about his work and to discuss it.

At the risk of digressing, may I make a personal confession, and say that the title "sampling with probability proportional to size", although well established in the literature as a name for the technique that Mr. Peaker has used, is one that seems to me slightly ambiguous. If the sizes of the sampling units constituting the population are in the ratios $p_1, p_2 \ \ldots \ p_N$ (where $p_1, + p_2 + \ \ldots \ p_N = 1$) and a sample of size n is to be drawn, then what is proportional to the size of any particular unit is the probability that that unit will appear as the ith member of the sample ($i = 1, 2 \ \ldots \ n$). Thus if U_r is a symbol representing the rth unit, the possible samples, and their chances of being chosen, are arrayed by the multinomial expansion

$$(p_1 U_1 + p_2 U_2 + = \ \ \ldots \ \ + p_N U_N)^n,$$

and, as is stressed in the literature, the same unit may on occasion appear more than once in the sample. The chance P_r that U_r appears in the sample is clearly $1 - (1 - p_r)^n$.

Alternatively, it might reasonably (but in fact mistakenly) be supposed that in "sampling with probability proportional to size" the investigator aims when drawing his sample at making each P_r proportional to the corresponding p_r. A simple example shows that in fact this type of proportionality cannot in general be achieved, if the number of units in the sample is pre-assigned. Let us suppose that it is required to draw a sample of two units from a total of three, and that in some proposed method of choosing the sample the chances that the pair of units chosen will be U_1U_2, U_1U_3, U_2U_3 are p_{12}, p_{13}, p_{23}. If P_1 is to be proportional to p_1, P_2 to p_2, etc., with k as the factor of proportionality, we must have

$$\begin{aligned} P_1 &= p_{12} + p_{13} \qquad\quad = kp_1 \\ P_2 &= p_{12} \qquad\quad + p_{23} = kp_2 \\ P_3 &= \qquad\quad p_{13} + p_{23} = kp_3, \end{aligned}$$

whence

$$\begin{aligned} 2p_{12} &= k(p_1 + p_2 - p_3) \\ 2p_{13} &= k(p_1 + p_3 - p_2) \\ 2p_{23} &= k(p_2 + p_3 - p_1), \end{aligned}$$

so that, p_{12}, etc., being essentially positive, p_1, p_2 and p_3 must be capable of representing the sides of a triangle. If this condition did not happen to be satisfied, no sampling method of the desired type could exist.

The remarks that I have just made are, of course, something of a digression. Returning to Mr. Peaker's paper, may I say that it affords investigators in all fields an example of the way in which sampling methods, properly applied, can reduce the cost of an inquiry without impairing the value of its results, and of the way in which complexities of organization, which at first sight might seem to make the adoption of sampling methods difficult, can in fact be turned to account. Educationists, I am sure, will welcome and if need be profit by Mr. Peaker's cautions against

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

over-generalization—cautions which would apply just as strongly to the interpretation of the results of a complete census as of a sample one. I personally envy the administrative skill that enabled Mr. Peaker to complete in a single day the investigation discussed in Sections VIII and IX, just as I admire his happy turn of phrase and apt choice of quotation. I have much pleasure in proposing a hearty vote of thanks.

Mr. W. J. CORLETT (in seconding the vote of thanks): I should like to congratulate Mr. Peaker on his interesting paper. He has attempted to apply the sampling methods of modern social surveys to the field of education. In doing so he has courageously combined two topics which frequently give rise to heated discussion. I assume that I have two main qualifications for seconding the vote of thanks. One is that I have never taken any part in social surveys. The other is that my knowledge of education is fragmentary.

As a non-specialist in this field I want to ask Mr. Peaker for some further information on one or two points. The first concerns the estimates of the variance of the mean in the reading inquiry. I am not quite sure what Mr. Peaker means by saying that he arranged his lists in geographical order, but I assume that it might result in systematic changes in the average score of an area and that a systematic method was used in choosing samples. The estimate of variance for the unadjusted mean would be inaccurate—probably too high. At some points in the paper this could be important. It might be, for instance, that such a systematic effect is due to systematic changes in the proportion of pupils in the different types of schools. In that event part of the gain in using the adjusted mean might only be apparent. There may no longer be the same over-estimate of sampling variance. Situations could arise in which the unadjusted mean would give a "better" estimate than the adjusted one. A simple case is where all the pupils in the areas selected are tested and the average score is the same for all the areas, the areas differing in the proportion of pupils in the different types of school. The unadjusted mean would be accurate, whereas the adjusted mean would have a positive sampling variance. Can we ever be certain which is the better estimate of the mean if the decision has to be based on a comparison of Q and Q'', which are not necessarily accurate estimates of sampling variances? I should also have found it useful if Mr. Peaker had given more justification for the use of Q'' as the basis for an estimate of sampling variance of the adjusted mean.

It would be useful if the analysis of the low correlation between the area means for composition and reading was extended. The variation in the composition score between areas seems to mix actual differences between the areas and differences between the teams marking the different areas. The team differences in the composition scores would be expected to lower the correlation. These differences would not be so important for the correlation between pupils. Unfortunately, it does not seem possible, now, to do anything about this point.

A second factor causing the low correlation between area means might be the fact that grammar schools seem to have a greater relative advantage in composition, particularly as compared with technical schools. This might bring the correlation between areas down through differences in the proportion of pupils in the different types of school. It might be useful to sort out any such effect.

There are two minor points. The statement is made that the sampling method was slightly biased in the direction of a defect in the all age type and an excess in the modern school type. With areas chosen with probability proportional to size should we not get an unbiased estimate of the population proportion in any type of school from the average of the area proportions?

I was puzzled by Mr. Peaker's reference to the sampling variances of the weights in connection with Table 1. I decided that the two ways of looking at Table 1 got a little mixed up in his discussion when he says that all the Q are zero, and that since these Q would be the sampling variances of the weights, when the weights are adjusted to their population values, they are *ex hypothesi* zero.

Dr. SAMPFORD: The first point I should like to raise stems from a remark made to me by Mr. Babington Smith, and concerns the actual conduct of the test within schools. The investigation was confined to children born within a period of three months, in consequence of which it was presumably necessary to remove these children from their class-mates for the purpose of the test. Now to remove a child from his normal working environment, and to give him a test savouring, no matter how slightly, of an examination, is bound to create some mental disturbance, which will presumably affect the quality of his work, and it seems possible that the severity of this disturbance may vary considerably between types of school. Would it not, therefore, be preferable to test whole classes of about the required average age, or, if this were impossible or considered likely to introduce too serious a variation of age, to test all children in all forms containing any children of the required age-group, selecting for marking only the scripts of these children? This would

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

increase the cost of the survey, but, in view of Mr. Peaker's remarks about the relative costs of sampling schools and pupils, it should do so only by a small fraction, which might not be considered excessive as leading to the removal of a possible source of bias.

The formula for $\bar{y}'$ based on the term Q'' seems to be an approximation obtained from the more exact form by replacing the population stratum proportions p_{ij}, etc., by the mean proportions in the sample. This approximation certainly eases the computations, but I have an uneasy feeling that it may introduce a bias, and result in the consistent under-estimation of $V(\bar{y}')$ (although I must admit that I have not yet been able to produce a satisfactory mathematical verification of my suspicions). A more satisfactory estimate is given by redefining $\bar{y}_i''$ as

$$\bar{y}_i'' = \Sigma \left(\frac{tp_j}{Sw_{ij}} \right) w_{ij}(\bar{y}_{ij} - \bar{y}_{jw}),$$

where summation is over school types, and following Mr. Peaker's procedure with the new $\bar{y}_i''$. The increase in labour would not be very serious, as the factors (tp_j/Sw_{ij}) and $(tp_j\bar{y}_{jw}/Sw_{ij})$ are constant for all entries in a particular column.

The comparison of first and second-stage sampling errors would surely be much more enlightening if carried out separately for each type of school, a procedure which would also avoid the necessity of pooling some of the more disparate variances. A single s_j^2 could be calculated for each type of school, by pooling within-stratum sums of squares from the different areas, and the first-stage sampling variance for, say, grammar schools, as calculated from Q_{ij}, could then be compared with the estimated contribution to it of the first-stage errors,

$$\frac{s^2_{ij}}{(sw_{ij})^2} \sum_i \frac{w^2_{ij}(1 - f_{ij})}{m_i}.$$

Finally, may I be permitted to express my dislike of Mr. Peaker's consistent use of the phrase "sampling error" to describe the sampling *standard* error? Admittedly his meaning is clear enough in the present context, and to the present company, but the two terms are not synonymous, and their use as if they were may well confuse the layman, who, intuitively thinking of "sampling error" as the actual difference between the estimated and true values, would be at a loss to understand why it should be given by the square root of a quantity called the "variance." I suspect Mr. Peaker of having fallen victim to a fourth "idol," which, following his example, I will christen the gooseberry bush, which consists of a belief that it is better to offer a simple but misleading explanation, argument, or phrase, than a more precise one which might not be immediately understood by all.

Mr. PEAKER (in reply): I should prefer to reply fully on paper, but there are one or two things I can say immediately. I think the effect of the systematic (as opposed to purely random) selection will be very slight. So far as there is any geographical stratification in the population the effect will be to make the estimate of the standard error of sampling a slight overestimate—i.e., to improve the accuracy of the sampling without registering the improvement in the standard error. The sample itself provides no evidence of a geographical stratification; if it exists it must be slight, and if it exists we have taken advantage of it. On Mr. Corlett's second point—the low correlation between the area means for reading and composition—I do not think this can be attributed entirely to the vagaries of marking. In the table of Section XI the variance of $X - Y$ is much smaller than the variance of $C - R$. The main conclusion I draw from this section is that if one is intending to use a calibration of one test against another the calibration itself ought to be done with a sample drawn from the whole area over which it is to be used, otherwise the result may be exceedingly misleading, as a comparison of the C and R entries in the same row of the table shows. The two things here, are, of course, of a more different character than a pair of tests to which calibration would usually be applied.

I thank the Society for receiving the paper, and I am glad that I have come through the discussion more unscathed than I had expected.

Mr. PEAKER subsequently wrote as follows:

I am most grateful to Mr. Fieller for his kind remarks, and to others who spoke, for a helpful discussion. It is, I think, true, as Mr. Fieller says, that this was the first attempt to apply a sampling method, which should be both rigorous and economical, in the educational field, in this or any other country. It was for this reason that it seemed worth while to report the methods used to overcome the difficulties arising from the nature, partly patterned and partly irregular, of the aggregate to be sampled, and from the need both to adopt a two-stage process, and to stratify by type of school. The two-stage process was not only economical; it was also advantageous in

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

this case because it brought out clearly the fact that there are quite considerable differences between areas, so that merely local inquiries can prove nothing about national standards. For example, there is a five-point difference between the highest and the lowest area means in Table 3, which is much greater than any likely change in the national mean over a few years. This is an important point, since fallacious arguments from purely local inquiries to national standards are frequently put forward.

I was very much interested in Mr. Fieller's clear exposition of the ambiguity in the expression "with probability proportionate to size" when one of what he calls the p_r is large. I had been vaguely conscious of the point, but had not thought it out in detail. In the present instance the p_r are all exceedingly small, since there are 146 L.E.A. in the Urban stratum, and the larger ones were subdivided. In these circumstances $1 - (1 - p_r)^n$ is effectively np_r, which leads to my equation (1). When the p_r are all small the chance of the same area being hit upon twice in a random selection is minute; none the less the strict theory is that if it is hit upon twice it ought to be included. In practice no one would actually include the same area twice, and under a systematic method of selection, provided n and all the p_r are small, the same area cannot be selected twice. The question rather reminds me of the anecdote about the man who was asked which church he went to, and said that in fact he didn't go to any, but he wanted to make it quite clear that it was the X denomination and not the Y denomination that he stayed away from.

I replied orally to Mr. Corlett's point about the systematic selection of areas, and I refer below to his second point, about Q''. On his third point, about the correlation between the area means for reading and composition, I said a few words which I should now like to expand. Mr. Corlett's point was that the variation in the composition scores between areas mixes actual differences between areas with differences between the teams marking the different areas. This is quite true (although the extent of the mixing can be seen by comparing the variances between areas of $X + Y$ and $X - Y$). Perhaps I ought therefore to say a little more about why the marking was organized in this particular way. The working hypothesis was that there was bound to be a good deal of marking error—that is difference between the opinions of two markers, or of the same marker at different times—and that, apart from unbiased errors, which he distributes randomly amongst a set of scripts before him at the same time, a marker may be held to have (compared with other markers) a bias towards severity or lenity, at a given time, and a fluctuation in this bias from time to time. This is certainly the simplest hypothesis which can conceivably cover the observed facts, though it may, of course, be too simple. If each batch of scripts contained the same proportion of 1952 and of 1949 scripts then, on the above hypothesis, the biases are eliminated from the comparison between the years, though not from the separate scores for each year.

To have both years represented in each batch was therefore cardinal, since the main object was a comparison of the years. Subject to this I considered the possibilities (*a*) of making the batches coincide with the areas or (*b*) making each batch extend right through both samples, by including in it only one (or no) script from each school. The latter would have given a better answer to Mr. Corlett's question but would have been more difficult to organize. There was a very short interval between the receipt of the scripts and the day for the marking, and since the entire marking had to be carried out in a single day there would have been no time to rectify mistakes if things had gone wrong through a too complicated organization.

But although the area means contain the team differences, the differences between school means within areas do not. Within areas there is very high agreement between school means in X and Y; the correlation for modern schools, for example, is ·93. On the other hand, the correlation between C and R for modern schools within areas is only ·34. This is low partly because boys do better than girls on the reading test, and girls better than boys on the composition, but the average correlation between school means for boys', girls' and mixed schools separately within areas is only ·56. This, I think, supports the view expressed in the paper that high correlations within schools between pupils may be associated with low correlations between school means and, *a fortiori*, between area means.

Having mentioned the sex differences I ought perhaps to add that the type means can be found as weighted means by an extension of the process of Table 3, and that, if the sample proportions had differed enough from the population proportions—which they did not—to make it necessary, an adjustment could have been made as in Table 5.

There is no doubt that the sampling of markers' opinions presents much more difficulty both in theory and practice than the sampling of pupils, schools and areas. The latter are all members of finite and specifiable populations, whereas it is hard to say of what the population of markers, and still more the population of marks, consists. There is a close analogy with the Indian crop surveys reported by Professor Mahalanobis in the *Journal* for 1946. Fields, villages, sub-districts, zones and provinces belong to finite and specifiable populations, and can be rigorously sampled.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Crop estimators do not, and cannot. However, though there are very large discrepancies between two estimators' views of the same field, yet interpenetrating samples covering vast areas give very much the same result. So here. At any rate, since the paper was read it has been possible to repeat the marking at another course, and thereby to form a view on whether the hypothesis covers the facts reasonably well. The results for the 1952 and the 1953 markings may be set out as follows:

	1952 *marking*		1953 *marking*	
	X	*Y*	*X*	*Y*
1952 scripts . .	109	105	110	112
1949 scripts . .	97	95	97	97
Gain (1952–1949) .	12	10	13	15

They are, I think, reasonably concordant. If we add the *X* and *Y* score for each year we get 22 and 28 points as the estimates of the gain. On the working hypothesis and the internal evidence the marking error to be attached to the first estimate of the gain is $\pm$ 2, and the corresponding figure for the second estimate is $\pm$ 3, for there was more random variation in the second marking. A direct comparison of the 22-point estimate with the 28-point estimate of the gain gives a mean of 25 $\pm$ 3 points, the $\pm$ 3 points being based on the single degree of freedom between the two sets of markers. The 1953 markers were clearly more variable than the 1952, but so far as it goes the comparison does not suggest that the combined sampling and marking error, estimated in the paper at $\pm$ 7, was appreciably in error.

I am obliged to Mr. Corlett for pointing out my slip in saying that the sampling method was slightly biased in the direction of a defect in the all age type. Selection with probability proportionate to size is, of course, unbiased in this as in many other respects. I had just been writing about a different design for another inquiry when I wrote this, and it is an example of what the psychologists call perseveration—persistence in an idea when it has ceased to be appropriate.

Dr. Sampford's first query—would it not have been better to take whole classes, and sort out the relevant scripts afterwards, instead of sorting out the relevant pupils beforehand?—raises an interesting point. It would, of course, have involved a very large increase in the numbers, and would, in fact, have meant a reprint of the reading test. My own experience of school inspection, extending now over a quarter of a century, does not suggest to me that pupils of fifteen are much disturbed by being collected into small groups for special exercises, at any rate provided they have no reason to suppose that the result of the exercise will have any momentous personal consequences.

Dr. Sampford is right in supposing that Q'' is an approximation obtained from the more exact form as he suggests. I think it is a legitimate approximation, so long, at any rate, as the sample proportions are reasonably close to the population proportions, in which case any bias introduced will be quite negligible. The approximation saves labour in that it merely involves the horizontal addition of the individual differences $(\bar{y}_{ij} - \bar{y}_{jw})$ already obtained for calculating the Q at the feet of the columns in Table 3. The exact method involves re-weighting these differences before adding them, but will lead to very much the same result. For example, in this instance the approximation gives $Q'' = 16{\cdot}20$ (Table 4) and the exact method gives $Q'' = 16{\cdot}64$, the corresponding estimates for the standard error of the adjusted mean being ·350 and ·355. It is perhaps hardly worth going through the re-weighting process in order to obtain so small an improvement.

Similarly, the actual difference between the result of Dr. Sampford's method of calculating the second-stage sampling variance, and mine, is exceedingly slight. Here, however, I am inclined to argue that mine is the better method, in the sense of being more appropriate to what may reasonably be supposed about the distribution of school means within areas. We both start, in effect, from the same basic expression

$$\frac{w^2_{im}\,(1 - f_{im})\,s^2_{im}}{m_i}$$

(as in Section V), where $s^2_{im}\,(m_i - 1)$ is the sum of squares for the ith area, and there are similar expressions for G, T, etc. I add these terms by rows and then add the row totals. Clearly I should get the same result if I first added columns, and then added column totals. Dr. Sampford proceeds by columns, but instead of simply adding the terms as they stand to get the column totals he first pools the sums of squares for the column, then multiplies the result by

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

$$\Sigma \frac{w^2_{im}(1-f_{im})}{m_i}, \text{ etc.,}$$

and then adds the column totals. Thus for the G and M columns I get ·220 and 4·60, while Dr. Sampford's method gives ·235 and 7·65. When each of these is divided by the appropriate $(Sw)^2$ we get the second-stage variances for the type mean, namely ·0248 ($=·157^2$) and ·0854 ($=·292^2$) from my procedure and ·0275 ($=·166^2$) and ·1087 ($=·330^2$) from Dr. Sampford's. When the columns are combined the corresponding estimates of the second-stage sampling error of the stratum mean are ±·18 on my reckoning (as given in Section V) and ±·21 on Dr. Sampford's.

These discrepancies, though small, are not wholly negligible, and it is therefore interesting to see how they arise. As a matter of arithmetic the major source of discrepancy is obvious. A glance at diagram 1 shows that in area 8 the sample contains more than the average number, and much more than the average spread, of modern schools. In fact area 8 contributes almost half the total sum of squares for the modern school column if we pool sums of squares. But (as is mentioned in Section V) the sampling fraction for area 8 is also larger than the average (·42 against ·27). This, and the fact that it also has more modern schools in the sample than the average area, produces two effects. On the one hand we get a more accurate estimate of the area mean, and therefore of the stratum mean; on the other hand area 8 makes a smaller contribution to the modern school variance under my method, of taking a weighted mean of the area variances, than under Dr. Sampford's method of pooling sums of squares. Hence the two methods give somewhat different results.

Moreover, since (*a*) we have different sampling fractions, and (*b*) there is no reason to suppose that the underlying area variances are in fact equal, I think my method is to be preferred. There is indeed reason to suppose that the area variances we are estimating are far from equal, since some L.E.A. areas are much more heterogeneous in social and economic character than others, and there are also differences in the organization of modern schools. The situation is therefore one in which it is more appropriate to make separate estimates with proper weighting rather than to pool sums of squares unweighted.

On Dr. Sampford's final point—his "dislike of Mr. Peaker's consistent use of the phrase 'sampling error' to describe the sampling *standard* error"—I am moved to protest. What is the title of Yates's Seventh Chapter? It is "Estimation of the Sampling Error". What is the first sub-head in the chapter? It is "Sampling Errors of a Random Sample". What are the opening words? They are "The general principles involved in the estimation of sampling errors . . . ". And who am I—nay, who is Dr. Sampford—that we should quarrel with such distinguished authority?

Having made my protest I hasten to agree with Dr. Sampford that the distinction should, when necessary, be made clear.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Soliman Hasan Abdel-Aty.
Wladyslaw Z. Billewicz.
Simon Ralph Broadbent.
Donald Frederick Cooper.
Douglas Owen Dillicar.
William Joseph Gleeson.
Geoffrey Caton Ogilvie.
Stephen Peto.
Sunil Kumar Roy.
Shayle Robert Searle.
John Tilston.
Charles Frederic Wright.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A Note on the Relation between Intelligence and Parental Income

By A. M. Walker

1. *Introduction*

It is very important at the present time that the best possible use should be made of the facilities for higher education in Great Britain. A great deal of attention is thus paid to the selection of school children for secondary or University education in an attempt to make this, as far as possible, dependent on ability. In any assessment of the effectiveness of this selection, it is clearly relevant to consider how the intelligence of children is related statistically to the income-group of their parents. The problem may be stated as follows: The income distribution of the country is such that there are very many more families with low incomes than with high. Thus the great majority of children in any age group come from families whose incomes are near the lower limit. On the other hand, it is well known that children whose parents belong to the higher income groups have *on the average* rather higher ability than those whose parents belong to the lower income groups. How far this is due to heredity or environment does not concern us here. However, the spread of ability about the average at any income level is certainly so great as to make it quite impossible to judge intuitively (i.e., without detailed calculation) how the two factors, (*a*) the greater number of low income families, (*b*) the greater average ability of the children with richer parents, should be combined to find out how the able children in the country are distributed over the different income groups.

If we accept a numerical scale of intelligence based on intelligence quotients (I.Q.'s) calculated from standard tests, we can consider the distribution of parental incomes for children whose I.Q. exceeds some minimum level, and can study how this varies as the minimum I.Q. level increases. To estimate these parental income distributions directly we should require values of I.Q. and annual parental income for a large number of children in some definite age-group, such as 11–13 years, corresponding approximately to the age of entrance to secondary schools. However, although much work has been done on the distribution of I.Q.'s—an outstanding example being the 1947 Scottish Survey (Scottish Council for Research in Education, 1949)—there seem to be few data relating to parental income, possibly because of the special difficulties which would be encountered in collecting it. This note describes an attempt to arrive at indirect estimates of the parental income distributions, by using existing information on

(*a*) the distribution of income of adult members of the population of Great Britain,
(*b*) the relationship between I.Q. and parental occupation.

It was necessary to make a number of simplifying assumptions, mainly of a rather drastic nature, but despite this it is thought worth while to record the results in some detail.

2. *The Income Distribution*

A simple approximation to the distribution of incomes in Great Britain is given by a Pareto law, according to which the number of persons with income $\geqslant i$ is proportional to $i^{-\alpha}$, $i \geqslant i_0$, where i_0 is an assumed minimum income, and $\alpha > 0$. This approximation cannot of course apply to the whole range of the income distribution, but is usually quite good for incomes greater than the mode. Estimates of α for recent years lie between 1·5 and 2·0, and the table below, taken from the *Bulletin of the Oxford Institute of Statistics* (Seers, 1948), shows that there has been a distinct trend towards equality of income distribution.

Table 1

Year	1938	1942	1945	1946
α	1·60	1·82	1·87	1·91

Over the last few years one might thus expect a Pareto law with α between 1·9 and 2·0 to be a reasonable approximation. Some confirmation of this was provided by details of the distribution

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of 21,000,000 incomes for 1947–1948, taken from the *Board of Inland Revenue Report* (1949). A Pareto law fitted to this distribution gave the value 1·90 for α, and the theoretical frequencies in Table 2. These agree fairly closely with the actual frequencies.

TABLE 2

Distribution of 21,000,000 *Gross Incomes for* 1947–1948

Income range (£ *per annum*)	<250	250–	500–	750–	1000–	1500–
Number of incomes (thousands)	9,375	9,000	1,490	475	355	130
Number expected with Pareto law	11,000	7,320	1,440	522	385	139

Income range (£ *per annum*)	2,000–	3,000–	5,000–	10,000–	20,000–
Number of incomes (thousands)	80·5	56·7	27·8	7·8	2·2
Number expected with Pareto law	103·5	55·0	24·5	6·6	2·4

It is to be noted that the above data refer to gross incomes. It is arguable whether net incomes (after deduction of tax) would be more appropriate, and in any case the effect of considering gross rather than net incomes was thought not to be very important in view of the number of approximations involved in the investigation.

What, in fact, we require is the distribution of *children* according to parental income, and account must therefore be taken of the fact that the average family size decreases as i increases. It was found difficult to do this in any precise way, but it seemed reasonable, as a rough approximation, to treat the effect on the income distribution as an increase in the Pareto index α, i.e., to assume that family size varies as $i^{-\delta\alpha}$. Now the average family size for unskilled labourers is at least twice that of professional workers (*Royal Commission Report on Population*, 1947, p. 152), and this indicates that a suitable value of $\delta\alpha$ would be about 0·3. It was thus decided to use a Pareto law with $\alpha = 2{\cdot}2$ to represent the parental income distribution. The minimum income i_0 was taken to be £200 per annum, a value which is near the mode of the distribution, and at the same time near a point beyond which the frequency function becomes very small—it was thought unlikely that there would be many children whose parents' income amounted to less than £4 per week. Thus if $n(i)\,di$ is the number of children with parental income in the range $(i, i + di)$, and N is the total number in the age-group being considered, our assumption gives

$$n(i) = 1{\cdot}1\,N(i/2)^{-3\cdot2}, \qquad i \geqslant 2, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where i is measured in units of £100 per annum.

3. *Distribution of Intelligence Quotient for Fixed Parental Income*

The distribution of parental income for children (in a particular age-group) with I.Q. not less than Q, may be specified by $n(i, Q)$, where $n(i, Q)\,di$ denotes the number of such children whose parents' income i lies in the range $(i, i + di)$. Now if $p(q \mid i)$ is the frequency density of the distribution of I.Q. q for fixed parental income i, we have

$$n(i, Q) = n(i)\int_Q^\infty p(q \mid i)\,dq. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Hence $n(i, Q)$ can be calculated if we can estimate $p(q \mid i)$. $p(q \mid i)$ was assumed to be normal with mean $m(i)$ and variance $\sigma^2(i)$, so that on substituting the value of $n(i)$ given by (1), we find

$$n(i, Q) = 1{\cdot}1\,N(i/2)n^{-3\cdot2}\left[1 - \Phi\left(\frac{Q - m(i)}{\sigma(i)}\right)\right], \quad . \quad . \quad . \quad (3)$$

where

$$\Phi(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{x} e^{-\frac{1}{2}z^2}\,dz.$$

$m(i)$ was taken to depend linearly on the logarithm of parental income, so that

$$m(i) = c + b \log i^*, \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

* All logarithms are to be taken to base 10, unless the base is explicitly stated.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

say. This assumption is admittedly arbitrary, but was considered to be the simplest one which might be hoped to be fairly realistic over the most important part of the range of parental incomes. A log linear relation between m and i is to be preferred to a linear relation, since a logarithmic scale is more appropriate for income than a linear scale, proportionate increases in income being roughly comparable.

Indications of suitable values for b and c may be obtained from studies of the relationship between I.Q. and parental occupation. Most of these, e.g. (6), have led to conclusions similar to those of Thomson and Duff (1923) in their pioneer Northumberland investigation. They obtained I.Q.'s and details of parental occupation for over 13,000 children in the age-group 11–13

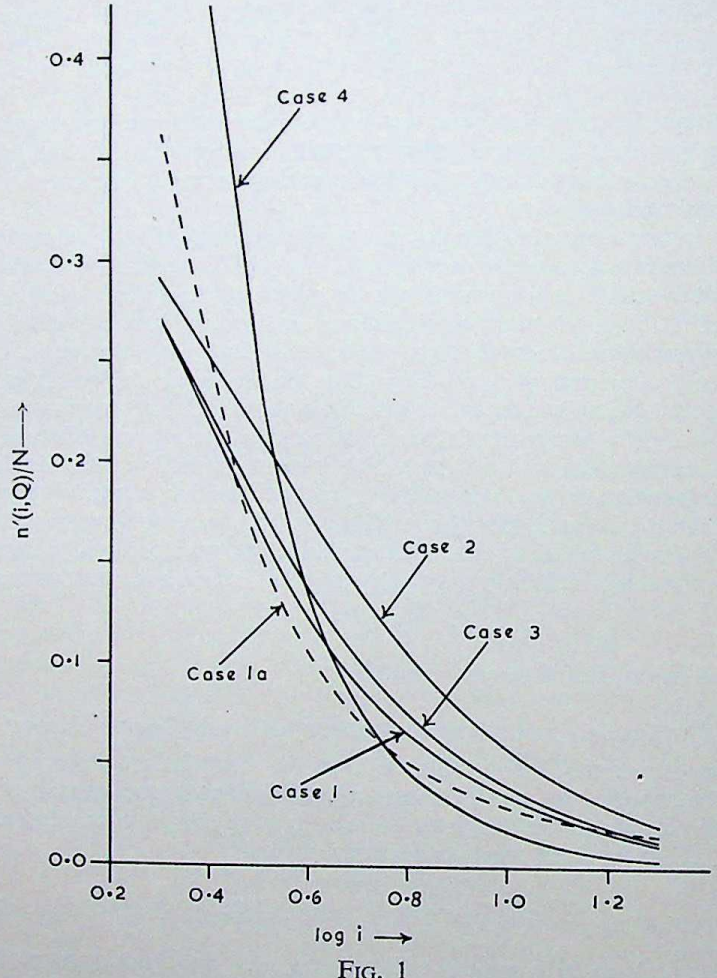


FIG. 1

years, and calculated the average values of I.Q. for a large number of different occupations, in addition giving the distribution of I.Q. for a number of classes formed by grouping together occupations more or less similar in standing. The means of these distributions ranged from about 94–96 for unskilled labouring classes to about 110–115 for higher managerial and professional classes, and there was definite evidence of increases in average I.Q. being associated with rises in occupational status. Several of the occupational classes could be regarded as corresponding to fairly homogeneous income groups, and this enabled a quantitative estimate to be made of the relationship between parental income and I.Q.

It was therefore considered reasonable to choose b and c in equation (4), so as to give $m(i)$ values between 94 and 96 at the lowest incomes (near £200 per annum), and values between 110

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and 115 at incomes in the range £1,000–£2,000 per annum. This suggested that c should lie between about 85 and 90, and b between about 15 and 25 (i being measured as before in units of £100 per annum). Calculations of the standard deviation of I.Q. within the above groups were consistent with $\sigma(i)$ being independent of i, having a constant value of about 13. These estimates of the range of variation of $m(i)$, and of $\sigma(i)$, may not necessarily be very accurate for the country as a whole, and may be affected considerably by the type of intelligence tests used, but they should at any rate be of the right order of magnitude.

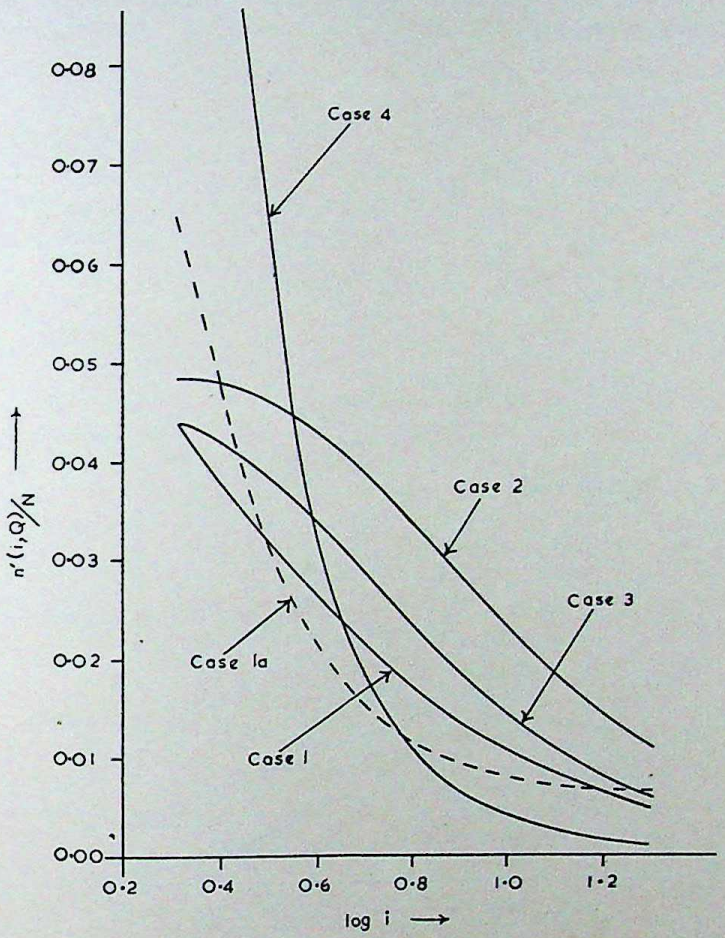


FIG. 2

Estimates of $n(i, Q)$ were obtained from equation (3) for the cases

(1) $c = 89$, $b = 17$, $\sigma(i) = 13$,

(2) $c = 87$, $b = 25$, $\sigma(i) = 13$.

The relation between mean I.Q. and income given by these two cases is illustrated in Table 3; case 1 was considered to be the more representative.

TABLE 3

Income (£ *per annum*)	200	300	400	500	600	800	1,000	1,250	1,500	2,000
Mean I.Q. (case 1)	94·1	97·1	99·2	100·9	102·2	104·4	106·0	107·6	109·0	111·1
Mean I.Q. (case 2)	94·5	98·9	102·1	104·5	106·5	109·6	112·0	114·4	116·4	119·5

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A further case (3) with $c = 89$, $b = 17$, $\sigma(i) = 13 + 2{\cdot}5 \log (i/2)$ was investigated, to see what would be the effect of a moderate rate of increase of spread about the regression line. Although Thomson and Duff's data gave no indication of an increase of $\sigma(i)$ with i, this seemed to be a possibility worth taking into account.

These log linear relationships can of course be reasonable approximations only for a limited range of income, and would lead to quite erroneous conclusions if applied at very high incomes. For this reason calculations were carried out only for values of i up to £2,000 per annum.

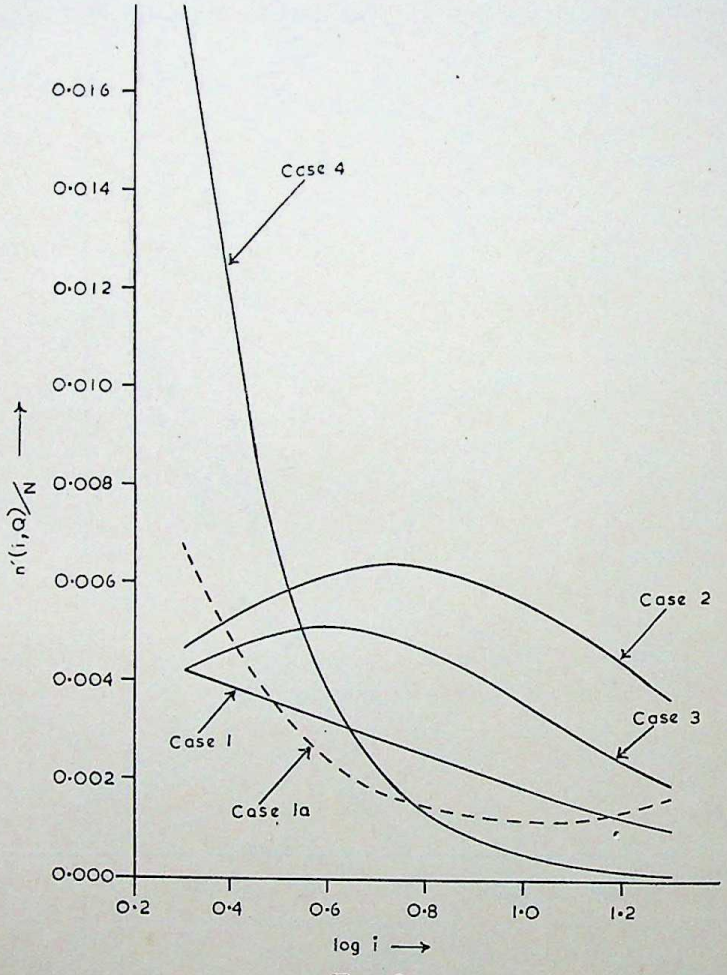


FIG. 3

The alternative assumption of a linear relationship, i.e., $m(i) = c' + b'i$, was at first considered, but this is obviously even more limited in its probable range of applicability, and it was found to lead to rather unrealistic results. However to illustrate the extent to which the behaviour of $n(i, Q)$ is influenced by the form of $m(i)$, the case (1a) for which $\sigma(i) = 13$, $c' = 94$, $b' = 1$, was included (these values of b', c', give a range of variation of $m(i)$ between incomes of £200 and £2,000 per annum, which is approximately the same as that for case 1).

4. *Calculation of* n(i, Q), *and Discussion of Results*

It was found convenient to work with the proportion $n(i, Q)/N$ (directly obtainable from equation (3)), rather than with the actual frequency density $n(i, Q)$, to avoid the necessity of obtaining an accurate estimate of N for a particular age-group. It may be noted, however, that

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

by interpolation from a table in the 1947 *Royal Commission Report on Population*, giving for 1947 the estimated number of persons in 5-yearly age-groups, a value of 1,240,000 was obtained for N for the age-group 11–13 years.

Since what is of interest is the income distribution of parents of children of reasonably high ability who would be likely to benefit by higher education, we need consider only values of Q well above the mean I.Q. for the whole age-group. This mean I.Q. is approximately 100, and the standard deviation of I.Q. for the whole age-group may be taken to be approximately 15, so that it would not be appropriate to calculate $n(i, Q)$ for values of Q much less than 115. Estimates of $n(i, Q)$ were in fact obtained for $Q = 115$, 125, 135 and 145; the proportions of the age-group

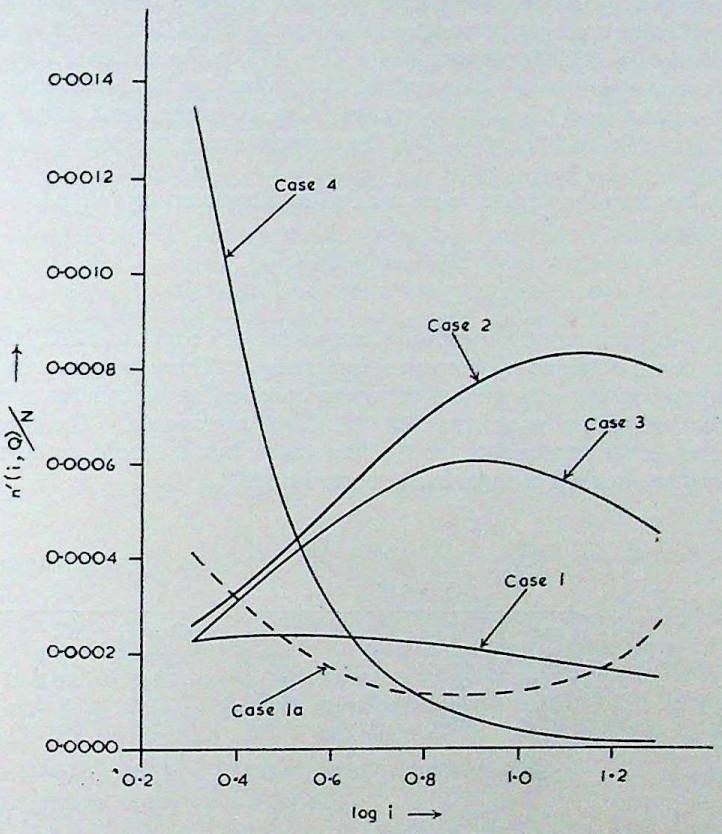


FIG. 4

having I.Q.'s greater than these values may be roughly estimated, on the basis of a normal distribution, as 1 in 6, 1 in 20, 1 in 100, and 1 in 1,000 respectively. $Q = 115$ corresponds approximately to the standard required at present for free places in secondary schools. $Q = 125$ may be thought of as very roughly indicating the level of ability required for potential University graduates, and $Q = 145$ as indicating really outstanding ability.

The results of the calculations are shown graphically in Figs. 1–4, in which, for each of the cases 1–3 and 1a,

$$\frac{n'(i, Q)}{N} = i \log_e 10 \left[\frac{n(i, Q)}{N}\right],$$

is plotted against $\log i$ for $Q = 115$, 125, 135, and 145. Results for case 4, for which $m(i) = 100$, $\sigma(i) = 13$ for all i, no relation between I.Q. and parental income being assumed, have been included for comparison.

Since $n(i, Q)\, di = n'(i, Q)\, d(\log i)$, the estimated proportion of children with I.Q. $\geqslant Q$ whose parents' income is less than or equal to i is given by the area under the appropriate graph bounded

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

by ordinates at i and the assumed minimum income $i_0(= 2)$. It was found convenient to plot $n'(i, Q)/N$ rather than $n(i, Q)/N$; in addition the choice of the logarithmic scale for income makes it easy to compare numbers of children with I.Q. $\geqslant Q$ having parental incomes in proportionate ranges, i.e., ranges corresponding to equal increments of log i.

From the graphs it can be seen that the influence of the assumed regression of I.Q. on parental income is very marked, there being large differences between cases 1–3 and case 4 for all the values of Q considered. For $Q = 115$, the curves for cases 1, 2 and 3 are of much the same shape, those for cases 1 and 3, being in fact almost identical, and we get a steady decrease of $n'(i, Q)/N$ as i increases. As Q increases, the divergence between the three cases becomes much more pronounced, and for $Q = 135$ and 145, the curves for cases 2 and 3 behave quite differently from those for case 1. In case 2 we get pronounced maxima of $n'(i, Q)/N$ near $i =$ £475 per annum for $Q = 135$, and near $i =$ £1,300 per annum for $Q = 145$, while in case 3 the maxima are less pronounced, and occur at somewhat lower values of i; near $i =$ £425 per annum for $Q = 135$, and $i =$ £850 per annum for $Q = 145$. For case 1, on the other hand, there is no maximum of $n'(i, Q)/N$ for $Q = 135$, and for $Q = 145$, the curve remains practically flat over the range £200–£450 per annum.

The differences between the various cases are further illustrated in Table 4. Estimates of the cumulative proportion

$$\int_{\log 2}^{\log i} \frac{n'(x, Q)}{N}\, d(\log x)$$

for four values of i in geometrical progression, approximately equal to £250, £500, £1,000, and £2,000 per annum, were obtained by numerical integration. These are given in Table 4 as percentages of the corresponding estimates of the overall proportion of children with I.Q. $\geqslant Q$, on the assumption that $m(i)$ remains constant for $i >$ £2,000 per annum. The overall proportions are also given; they differ appreciably for the four cases, but it should be borne in mind that they are quite sensitive to small changes in the spread of I.Q.

TABLE 4

i (£ *p.a.*)	Q = 115				Q = 125			
	Case (1)	(2)	(3)	(4)	*Case* (1)	(2)	(3)	(4)
250	25·5	21·1	24·2	39·9	20·0	14·1	17·1	39·9
500	71·6	66·3	70·9	86·9	62·6	52·6	59·3	86·9
1,000	90·6	88·5	90·6	97·2	85·2	79·5	84·1	97·2
2,000	97·5	97·0	97·6	99·4	95·7	93·9	95·5	99·4
Overall proportion	·096	·130	·103	·124	·0206	·0344	·0255	·0272

i (£ *p.a.*)	Q = 135				Q = 145			
	Case (1)	(2)	(3)	(4)	*Case* (1)	(2)	(3)	(4)
250	14·6	8·0	10·0	39·9	9·7	3·8	4·6	39·9
500	51·6	36·6	43·8	86·9	39·4	21·8	27·0	86·9
1,000	77·2	65·9	73·0	97·2	66·5	49·2	57·2	97·2
2,000	92·6	88·4	91·4	99·4	88·1	80·4	84·7	99·4
Overall proportion	·00280	·00630	·00449	·00355	·000241	·000802	·000591	·000269

It can be seen that the effect of modifying the assumptions of case 1, either by increasing the slope of the regression line or by allowing the variance of I.Q. about the regression line to increase with i, is quite large. This indicates that the results depend very much on the particular form of the regression function. Further evidence is provided by the behaviour of the curves for case 1a. Those for $Q = 115$ and $Q = 125$ bear a fairly close resemblance to the curves for case 4, the flattening-out effect being concentrated chiefly in the high income region, but for $Q = 135$ and $Q = 145$ there is an appreciable dip in the curves towards the middle of the income range, with a minimum of $n'(i, Q)/N$ near $i =$ £1,000 per annum. Such an effect seems unrealistic, confirming the opinion that the assumption of linear regression of q on i is inappropriate.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It would thus be rather dangerous to attach much weight to any detailed conclusions which may be drawn from these results. We may note, however, that none of the cases 1–3 give a concentration of ability at high parental incomes, and the general implication that the majority of children of high intelligence have parents who belong to the lower income groups may perhaps be accepted with some confidence (compare Gray and Moshinsky, 1938, pp. 406, 416).

5. *Relation of Results to Student Sampling Inquiry at Manchester University*

In view of the difficulty of assessing the value of these estimates of $n'(i, Q)/N$ in the absence of direct experimental evidence, it was thought worth while to see whether any relevant information could be obtained from the results of a sampling inquiry into the parental income of students at Manchester University, which was carried out in the early part of 1950. This related to the income for the financial year ending April, 1949, of parents and foster parents of full-time degree students in their first or second year during 1949–1950. From these students, numbering 2,133, a sample of 262 was taken strictly at random, subject to being as far as possible representative as regards sex, year, and faculty. The inquiry was on a purely voluntary basis, and a system of coding was used so that individual incomes should not be identified with particular students, the information thus being strictly confidential.

184 replies (excluding blanks) were received, giving the income distribution of Table 5. There is of course the danger of bias with anything less than a 100 per cent. response. However, analysis of the replies suggested that the income distribution was reasonably free from bias, except perhaps that due to a group of students with high parental incomes refusing to reply.

TABLE 5

Income (£ *per annum*)	<250	250–299	300–349	350–449	450–549	550–699	700–849
No. of students	11	9½	21	38½	25	30½	13½

Income (£ *per annum*)	850–999	1,000–1,199	1,200–1,499	1,500–1,999	2,000–2,499	2,500–
No. of students	8	10	9	4	2	2

(A few replies gave two income groups, in which case a frequency of ½ was assigned to each group.)

The I.Q.'s of the students were not known, but it seems reasonable to suppose that the distribution of these was highly positively skew, with the majority of values above $q = 125$. Hence we might expect that the distribution of parental incomes obtained from the student sample should bear some resemblance to that for the whole age-group with I.Q. $\geqslant 125$. If we further assume that the age-groups 11–13 years and 18–25 years (say) do not differ appreciably in respect of—

(*a*) the relationship between I.Q. and parental income, and
(*b*) the distribution of parental income,

we may compare the distribution of Table 5 with those obtained in §4 for $Q = 125$. It was thought that the increase of income with age which occurs in many occupations would not seriously affect this assumption, and that therefore the comparison might throw some light on the relative merits of the different forms assumed for the regression of I.Q. q on parental income i. Of course the validity of the comparison also depends on selection for University education being governed mainly by ability, and not *directly* by parental income. This was very far from being true in the past, but at the present time, especially for a University in an industrial area, the direct influence of parental income is perhaps not very great. In Table 6 the frequency distribution of Table 5 for incomes up to £2,000 per annum is compared with the corresponding expected frequencies calculated on the assumptions of cases 1, 2, 3 and 4.

All four cases give frequencies diverging widely from those of the student sample at the lower end of the income range. This may be partly due to the inadequacy of the Pareto law for low incomes. A fairer basis of comparison might be obtained by combining the frequencies for the first four income groups covering the range up to £450 per annum. When this is done, it can be seen that on the whole the best fit to the frequencies of the student sample distribution is given by the expected frequencies of case 2. However, the fit is not a great deal better than that provided by the expected frequencies of cases 1 or 3, although only in case 2 do we get a value of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 6

Income range (£ *per annum*)	*Student Sample*	*Case* (1)	*Case* (2)	*Case* (3)	*Case* (4)
<250	11	36·5	26·1	31·1	70·3
250–299	9·5 } 80	25·8 } 107·8	20·9 } 90·1	23·9 } 101·1	36·6 } 150·8
300–349	21	19·1	17·1	18·8	21·4
350–449	38·5	26·4	26·0	27·3	22·5
450–549	25	17·2	18·8	18·5	10·9
550–699	30·5	16·8	19·8	18·4	8·1
700–849	13·5	10·8	13·7	12·0	4·0
850–999	8	7·5	9·9	8·3	2·3
1,000–1,199	10	6·9	9·4	7·7	1·7
1,200–1,499	9	6·7	9·4	7·3	1·4
1,500–1,999	4	6·3	9·0	6·7	1·0

χ^2 which is not significantly high. Nevertheless the χ^2 test is of doubtful validity here, and in view of all the approximations involved in the comparison, it would be very dangerous to say more than that there is some slight evidence for preferring the hypothesis of case 2 to those of cases 1 or 3. The poor fit provided by the expected frequencies of case 4 is not surprising, since it is well established that there is *some* relationship between I.Q. and parental income.

Acknowledgments

This investigation arose originally from a suggestion by Professor P. M. S. Blackett. I am also indebted to Professor M. S. Bartlett for helpful advice and criticism, to Mrs. A. Linnert for the preparation of the graphs and for help with the calculations, and to those who co-operated by supplying information in the Student Sampling Inquiry.

References

Board of Inland Revenue (1949), 91*st Report of the Commissioners* [Cmd. 7738]. London: H.M.S.O.

GRAY, J. L., & MOSHINSKY, P. (1938), "Ability and educational opportunity in relation to parental occupation", *Political Arithmetic* (ed. L. Hogben). London: Allen & Unwin.

Royal Commission on Population (1949), *Report* [Cmd. 7695]. London: H.M.S.O.

Scottish Council for Research in Education (1949), *The Trend of Scottish Intelligence*. London: University Press.

SEERS, D. (1948), *Bull. Oxf. Inst. Statist.*, **10**, 313.

THOMSON, G. H., & DUFF, J. F. (1923), "The social and geographical distribution of intelligence in Northumberland", *Brit. J. Psychol.*, **14**, 192.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Problem of Exceptional Samples in Agricultural Sample Surveys

By W. D. Burrowes

In an extensive sample survey of agricultural production in Jamaica 1950–51 (Burrowes, 1952) certain problems were encountered in computation which are recorded because they appear to have a general application to sample surveys in agriculture. This survey was designed to estimate acreage and production of selected agricultural products. The sample was stratified according to local administrative areas (parishes) and according to the following eight size groups of farms: 1–4 acres, 5–9 acres, 10–24 acres, 25–49 acres, 50–99 acres, 100–199 acres, 200–499 acres, 500 acres and over.

The three examples given below appear to illustrate one general point, namely, that in sample surveys of agriculture very atypical cases may be encountered which may have important effects on the computations unless some adjustment is made on the basis of independent information. That is, the sampling method and subsequent computations are not in practice self-sufficient to give reliable results, and investigators have to be prepared to examine all data critically in the light of all the knowledge available regarding the material being investigated. The danger is of the same kind as that of laying undue stress on significant differences in the case of field experiments. In this latter connection the stages which go to make up a thorough investigation have been neatly defined by Anscombe (1948), and his remarks are equally applicable to sample surveys.

The occurrence of strikingly atypical cases expresses the fact that the distribution of the population measurements with which one is dealing in agricultural surveys probably does not approach closely to a normal distribution owing to the complications introduced by the element of human decisions in agriculture. It appears that nothing but independent knowledge can adequately safeguard the possibility of errors from this source in sample surveys.

It may be argued that the danger would be partly avoided if the sample were sufficiently large, but it is not always possible to estimate beforehand how large a sample would be needed, even if a sample of the desired size were always possible on other grounds.

The examples encountered were the following :

1. One farm in the 1–4-acre class, situated in a non-citrus-producing parish, were found to have nearly three acres of citrus. This was due to an exceptional decision on the part of the farmer to plant out his entire holding in citrus. If standard errors were calculated for each item in each stratum of the sample this case would be detected by perusal of the standard errors, but it is not always considered worthwhile in extensive surveys to calculate sampling errors for every item and sub-item. In this case the situation was detected in the course of detailed perusal of the computations. It was decided to reduce the raised total of number of citrus plants in that size group of that parish by comparison with the data for other citrus varieties in the same parish. If the theoretically correct figure had been adopted the answer presented would have been obviously inflated.

2. The second case arose in connection with fragmentation of farms, which is constantly encountered in agricultural surveys, particularly when the frame is not up-to-date. In this survey fragmented farms were accounted for by calculating the number of new farms produced by fragmentation, and assuming that these farms behave like other farms in the same size groups in the same parish. But in one case a large farm, which subsequently became fragmented, had specialized in the production of a permanent crop (citrus). When this farm became fragmented the average intensity of production of citrus on the resulting small farms was much higher than that of other small farms in the parish, so that the above method of estimation would give very low figures for the parish. This case may be generalized by saying that it is dangerous to assume that small farms formed by recent fragmentation of large estates will have a pattern of agricultural production similar to that of other small farms in the area, because of the likelihood of specialized developments on the large farms. This case was partly the result of having to use an out-of-date frame, but the same danger will

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

usually be present, more or less, and it is only careful consideration of subsidiary information which can detect such cases. This case was in fact detected by comparing the parish totals with those obtained in a previous agricultural census and then searching for the source of the observed discrepancy.

3. The third case also arose in connection with the transfer of farms from one size group to another. In such cases it is usual to raise the numerical data in their original size group and transfer the raised totals to the new size group. In a special sample of sugar-cane production, stratified by areas and by tonnage of cane produced in the previous year, one producer in the 200–499-ton class of one area was found to have produced 1,200 tons, that is, very considerably above his previous production. This amount of 1,200 tons when multiplied by the raising factor (16) made an appreciable addition to the higher class of 500 tons and over. Since it was known that this was a special case and it was extremely unlikely that sixteen producers in the area had made a like change of production, it was decided to transfer the production of this single farm to the higher class (without raising), contrary to the correct theoretical procedure. In effect, the case was treated as though this farm originally belonged to the higher class, and had been placed in the lower class by mistake.

These examples illustrate the danger of errors occurring in the computation stage of sample surveys if too much confidence is placed in the process of computation itself and if there is not sufficient knowledge of the material with which one is dealing and vigilance in looking out for special cases. Many sources of error in other stages of sample survey work have been dealt with in detail in well-known works on sample surveys (Deming, 1950, Yates 1949).

References.

ANSCOMBE, F. J. (1948), "Validity of comparative experiments", *J. R. Statist. Soc.*, A **111**, 141.
BURROWES, W. D. (1952), "Sample survey of production of selected agricultural produce", *Dept. Agric. Jamaica*, Bull. **48**.
DEMING, W. E. (1950), *Some Theory of Sampling*. New York: John Wiley.
YATES, F. (1949), *Sampling Methods for Censuses and Surveys*. London: Griffen.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Bibliography of Applications of Mathematical Statistics to Economics

Supplement for 1950

By A. D. Scott

PAGE

I. Introduction 177
II. The Classification Systems 177
III. Bibliography 179
IV. Economic Classification 182
V. Mathematical-statistical Classification 184

I. *Introduction*

This bibliography of applications of mathematical statistics to economics is a supplement to that prepared under the direction of a committee of the Department of Applied Economics, Cambridge, and published in the *Journal of the Royal Statistical Society* in 1951. The original covered articles and books published from 1943 to 1949 and the purpose of this supplement is to record contributions published in the following year, 1950, and also to include certain articles and books published during the earlier period, 1943–1949, which for one reason or another were not included in the first bibliography. Suggestions and assistance from correspondents in other countries, some of which we were unable to incorporate earlier, have been used in the preparation of this supplement.

The assistance of Mrs. M. A. Cosgrove in arranging, checking and typing the entries is also gratefully acknowledged.

The list of periodicals consulted is substantially the same as that used in the original bibliography. Most of the articles listed in the bibliography have been seen before being classified; but a number of the titles suggested by correspondents abroad and a few which were taken from authors' footnotes and bibliographies were not readily available and were classified on the basis of the information obtained from those sources.

The determination of what is, and what is not, an economic application of mathematical statistics has turned on whether the author has applied a method involving stochastic considerations to the analysis of genuine economic data in order to obtain results of economic significance. The use of mathematics in general economic theory has therefore been excluded as being neither applied to actual data, nor requiring consideration of stochastic problems. Although it has been necessary to apply the criterion rather loosely in some cases, there has been a consistent intention to exclude simpler techniques such as graphical illustration, and free-hand curve fitting; and to include all applications of sampling theory, correlation, graduation, variance analysis, and the more advanced methods such as simultaneous and autoregressive equations.

In section III the papers have been listed in alphabetical order of the author's name, and given serial numbers, which have been used in the system of classification in section IV and V. The first serial number, No. 598, follows the last one of the earlier bibliography. Section IV sets out thirteen general economic applications, subdivided into more specialized phases of the subject, and under each have been listed the serial numbers of the appropriate articles. (The serial numbers in parentheses refer to articles which concentrate on the exposition of technique and theory rather than concentrating on actual application). Section V classifies each article according to the mathematical-statistical method used, so that each article can be found by author, by economic subject, and by statistical method. The classification scheme is summarized below.

II. *The Classification Systems*

A. Economic Classification

1. *Collection of Data Concerning Micro-Economic Behaviour*

(*a*) Family budget surveys.
(*b*) Surveys of other economic units.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2. *Estimation of Size Distributions*
   - (*a*) Income.
   - (*b*) Wealth.
   - (*c*) Consumption.
   - (*d*) Production.
   - (*e*) Taxes.

3. *Estimation of Social Accounting Aggregates*
   - (*a*) Income.
   - (*b*) Wealth.
   - (*c*) Consumption.
   - (*d*) Production.
   - (*e*) Taxes.

4. *Graduation, Reliability and Adjustment of Economic Data*
   - (*a*) Income.
   - (*b*) Wealth.
   - (*c*) Consumption.
   - (*d*) Production.
   - (*e*) Taxes.

5. *Demand Functions*
   - (*a*) Consumers' goods:
     - (i) Consumption as a whole;
     - (ii) Particular goods.
   - (*b*) Producers' goods.
   - (*c*) Imports and exports.
   - (*d*) Money and other assets: debts.

6. *Production, Cost and Supply Functions*
   - (*a*) Individual firms and industries:
     - (i) Agriculture;
     - (ii) Other industries;
     - (iii) National or whole economy functions.
   - (*b*) Labour supply.
   - (*c*) Business size, profitability; number of firms.
   - (*d*) Inter-industry input-output relationships.

7. *Models of Particular Markets*
   - (*a*) Consumers' goods markets.
   - (*b*) Producers' goods markets:
     - (i) Agriculture;
     - (ii) Other.
   - (*c*) Labour markets.
   - (*d*) International markets.
   - (*e*) Financial markets.
   - (*f*) Market structure and price determination.
   - (*g*) Economic growth patterns.

8. *Explanations of Distribution of Incomes*
   - (*a*) Functional.
   - (*b*) Industrial.
   - (*c*) Regional.
   - (*d*) Business financial policy.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

9. *Interrelations Between Government and the Economy*

10. *Business Cycle Models*

11. *Other Economic Relationships*

12. *Index Numbers*

13. *Theoretical and Expository Articles on the Application of Mathematical Statistics to Economics.*

B. Mathematical-Statistical Classification

21. *Measurement of Economic Magnitudes by Sampling Methods*

22. *Subjective Assessment of Errors of Observation and their Use in the Adjustment of Observations*

23. *Specification of Frequency Distributions of Economic Variables*

24. *Testing Hypotheses Concerning Economic Relationships, Estimation of Parameters and Prediction*
   (*a*) Analyses of variance and co-variance.
   (*b*) Other applications of classical regression.
   (*c*) Confluence analysis.
   (*d*) Simultaneous equations.
   (*e*) Autoregressive single equations.
   (*f*) Other models.

III. *Bibliography*

598. ARMORE, S. J., & BURTIS, E. L. (1950), "Factors affecting consumption of fats and oils, other than butter, in the United States", *Agric. Econ. Res.*, **2**, 1–9.
599. ATKINSON, L. J. (1950), "The demand for consumers' durable goods", *Surv. Curr. Bus.*, **30**, No. 6, 5–10.
600. BAKER, R. L. (1950), "Predicting annual egg production in the United States", *J. Farm Econ.*, **32**, 658–62.
601. BANKS, S. (1950), "The relationships between preference and purchase of brands", *J. Marketing*, **15**, 145–57.
602. BEETSMA, J. S., & VAN ÖLST, H. R. (1950), "De vraag naar bloembollen in de Verenigde Staten van Amerika", *Statist. Econ. OndZoek.*, **5**, 22–31.
603. BELLAMY, J., & BOWEN, I. (1950), "A survey of consumer expenditure", *Yorks. Bull. Econ. Social Res.*, **2**, 31–62.
604. BELLOC, N. B. (1950), "Labor-force participation and employment opportunities for women", *J. Amer. Statist. Ass.*, **45**, 400–10.
605. BRAMBILLA, F. (1950), "Il metodo del campione come tecnica di rilevazione statistica", *L'industria*, **65**, 545–63.
606. BRAMBILLA, F. (1950), "Sull' invarianza della forma della distribuzione dei redditi", *L'industria*, **64**, 217–27.
607. BREIMYER, H. F. (1950), "Some comments on factors influencing differences between state per capita incomes", *Sth. Econ. J.*, **17**, 140–7.
608. BROWN, G. H. (1950), "Measuring consumer attitudes toward products", *J. Marketing*, **14**, 691–8.
609. BUCKATZSCH, E. J. (1950), "The geographical distribution of wealth in England, 1086–1843", *Econ. Hist. Rev.*, **3**, 180–202.
610. CÂMARA, L. (1950), "Notas intródutorias à metodologia estatística dos salários", *Rev. Bras. Estatíst.*, **11**, 263–86.
611. CAVE, R. C. (1950), "Prewar-postwar relationship between disposable income and consumption expenditures", *Rev. Econ. Statist.*, **32**, 172–6.
612. CHABERT, A. (1950), "Le système d'input-output de W. Léontief et l'analyse économique quantitative", *Écon. Appl.*, **3**, 173–205.
613. CHAUDHURI, N. C. (1950), "A statistical analysis of the family budgets of industrial workers at Nagpur", *Sankhyā*, **10**, 119–22.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

614. CLARK, E., & FISHMAN, L. (1950), "Further remarks on estimating the size distribution of a given aggregate income", *Rev. Econ. Statist.*, **32**, 106–7.
615. D'ADDARIO, R. (1949), "Pesquisas em tôrno da curva das rendas", *Rev. Bras. Estatíst.*, **10**, 531–47. Portuguese translation of entry 109.
616. D'ELIA, E. (1950), "Aspetti economici delle utilizzazioni legnose dei boschi", *Ann. Statist.* (Rome), **4**, 101–74.
617. FEGIZ, P. L. (1950), "La distribuzione del reddito nazionale", *G. Econ. Ann. Econ.*, **9**, 341–54.
618. FERGUSON, A. R. (1950), "Empirical determination of a multidimensional marginal cost function", *Econometrica*, **18**, 217–35.
619. FREIRE, J. R. (1950), "Sobre os rendimentos pessoais em Portugal", *Revista de Economia*, **3**, 1–13.
620. FULMER, J. L. (1950), "Factors influencing state per capita income differentials", *Sth. Econ. J.*, **16**, 259–78.
621. GARBARINO, J. W. (1950), "A theory of interindustry wage structure variation", *Q. J. Econ.*, **64**, 282–305.
622. GHOSH, A. (1950), "A note on the marginal and the optimum size of holding in Bengal", *Sankhyā*, **10**, 383–6.
623. GIACCARDI, F. (1950), "Indici di concentrazione", *G. Econ. Ann. Econ.*, **9**, 281–9.
624. GIACCARDI, F. (1950), "Sulla 'diseguaglianza dei redditi' nelle ipotesi paretiane", *G. Econ. Ann. Econ.*, **9**, 355–61.
625. GRAY, P. G., & CORLETT, T. (1950), "Sampling for the Social Survey", *J. R. Statist. Soc.*, A, **113**, 150–206.
626. HARBERGER, A. C. (1950), "Index number problems in measuring the elasticity of demand for imports", *Econometrica* (abstract), **18**, 275–6.
627. HARGREAVES, J. A. (1950), "U.S. import propensities since the war", *Bull. Oxf. Inst. Statist.*, **12**, 60–4.
628. HENDERSON, A. (1950), "The cost of children", Pts. 2 and 3, *Population Stud.*, **4**, 267–98.
629. HENDERSON, A. (1950), "The cost of a family", *Rev. Econ. Stud.*, **17**, 127–48.
630. HOUSEMAN, E. E. (1950), "Sampling methods in marketing research", *Agric. Econ. Res.*, **2**, 73–81.
631. JACOBS, W., & WINSTON, C. (1950), "The postwar furniture market and the factors determining demand", *Surv. Curr. Bus.*, **30**, No. 5, 8–11.
632. JURÉEN, L. (1950), "Konsumtionen av livsmedel vid en avveckling av subventionerna på jordbrukets område", *Ekon. Tidskr.*, **52**, 175–95.
633. KATONA, G., *et al.* (1950), "Methods of the survey of consumer finances", *Fed. Reserve Bull.*, **36** 795–809.
634. KELLERER, H. (1950), "Das Stichprobenverfahren, insbesondere in der amtlichen Statistik", *Allg. Statist. Arch.*, **34**, 291–302.
635. KLEIN, L. R. (1950), *Economic Fluctuations in the United States*, 1921–1941. New York: Wiley, Cowles Commission monograph 11.
636. KLEIN, L. R. (1950), "The integration of cross-section and time-series data", *Econometrica* (abstract), **18**, 280–1.
637. KOHLS, R. L. (1950), "A technique for anticipating change in the volume of egg storage", *J. Farm Econ.*, **32**, 663–6.
638. KOOPMANS, T. C., *et al.* (1950), *Statistical Inference in Dynamic Economic Models*, New York: Wiley, Cowles Commission monograph 10.
639. KUBINSKI, Z. (1950), "The elasticity of substitution between sources of British imports, 1921–1938", *Yorks. Bull. Econ. Social Res.*, **2**, 17–29.
640. LA ROCHE, C. (1950), "Empirische Konsum- und Spar-funktionen", *Schweiz. Z. Volksw. Statist.*, **86**, 193–218 and 338–54.
641. LESER, C. E. V. (1950), "Output per head in different parts of the United Kingdom", *J. R. Statist. Soc.* A, **113**, 207–19.
642. LIU, T.-C., & CHANG, C.-G. (1950), "U.S. consumption and investment propensities: prewar and postwar", *Amer. Econ. Rev.*, **40**, 565–82.
643. LOMAX, K. S. (1950), "The demand for potatoes", *Manch. Sch. Econ. Social Stud.*, **18**, 175–6.
644. LOMAX, K. S. (1950), "Production functions for manufacturing industry in the United Kingdom", *Amer. Econ. Rev.*, **40**, 397–9.
645. LONGMORE, K. M. (1950), "American tourist expenditure and the European balance of payment", *Bull. Oxf. Inst. Statist.*, **12**, 65–73.
646. MADOW, L. H. (1950), "On the use of the county as the primary sampling unit for state estimates", *J. Amer. Statist. Ass.*, **45**, 30–47.
647. MALINVAUD, E. (1950), "Les élasticités par rapport aux prix dans les échanges internationaux", *J. Soc. Statist. Paris*, **91**, 177–88.
648. MAY, K. (1950), "A note on the pure theory of production", *Econometrica*, **18**, 56–9.
649. METELIUS, B. (1946), "Prisläget våren 1946", *Med. KonjInst.* (B), 5–29.
650. MOURRE, le baron (1950), "Définition et évolution de l'inégalité des revenus", *J. Soc. Statist, Paris* **91**, 294–320.
651. NORRIS, N. (1950), "Methods of measuring absolute and relative variations in the duration of business cycles", *Econometrica* (abstract), **18**, 301–2.
652. ORCUTT, G. H. (1950), "Measurement of price elasticities in international trade", *Rev. Econ. Statist.*, **32**, 117–32.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

653. OXENFELDT, A. R. (1950), "Consumer knowledge: its measurement and extent", *Rev. Econ. Statist.*, **32**, 300–14.
654. PALMER, C. D., & SCHLOTZHAUER, E. O. (1950), "Methods of forecasting production of fruit", *Agric. Econ. Res.*, **2**, 10–9.
655. PESMAZOGLU, J. S. (1950), "Some international aspects of British cyclical fluctuations", *Rev. Econ. Stud.*, **16**, 117–43.
656. PESMAZOGLU, J. S. (1950), "Some international aspects of German cyclical fluctuations, 1880–1913", *Weltw. Arch.*, **64**, 77–110.
657. PHILIP, K. (1949–50), "A statistical measurement of the preference of private banks", *Rev. Econ. Stud.*, **16**, 71–7. English version of entry 380.
658. POLAK, J. J. (1950), "An international economic system", *Econometrica* (abstract), **18**, 70–2.
659. POLAK, J. J. (1950), "Note on the measurement of elasticity of substitution in international trade", *Rev. Econ. Statist.*, **32**, 16–20.
660. QUENOUILLE, M. H. (1950), "An application of least squares to family diet surveys", *Econometrica*, **18**, 27–44.
661. RHODES, E. C. (1950), "Distribution of incomes in the United Kingdom in 1938 and 1947", *Economica*, **17**, 146–58.
662. ROY, A. D. (1950), "The distribution of earnings and of individual output", *Econ. J.*, **60**, 489–505.
663. SASSCER, F. P. (1950), "American expenditures for foreign travel in 1949", *Surv. Curr. Bus.*, **30**, No. 3, 16–20.
664. SCHECHTER, H. B. (1950), "An analysis of commercial construction", *J. Land Pub. Util. Econ.*, **26**, 114–35.
665. SCHULZ, T. (1950), "Working class household expenditure in 1948", *Bull. Oxf. Inst. Statist.*, **12**, 81–98.
666. SCHWARTZMAN, O. (1950), "A note on the supply of female labor", *Rev. Econ. Statist.*, **32**, 159–61.
667. SLICHTER, S. H. (1950), "Notes on the structure of wages", *Rev. Econ. Statist.*, **32**, 80–91.
668. SOMERMEIJER, W. H. (1950), "Zitplaatsaccomodatie van bioscopen in Nederland, en de factoren die haar bepalen; een economisch onderzoek", *Statistica*, **5**, 195–203.
669. STEVENS, S. P. (1950), "The importance of wool in Australia's national income", *Econ. Rec.*, **26**, 217–38.
670. STONE, J. R. N., *et al.* (1950), "The use of sampling methods in national income statistics and social accounting", *Account. Res.*, **1**, 333–56 and *Rev. Inst. Int. Statist.*, **18**, 21–44.
671. STORCH, J. M. (1950), "Het gebruik van bewegende gemiddelden voor de analyse van een economische grafiek", *Statistica*, **4**, 37–53.
672. STUVEL, G., & JAMES, S. F. (1950), "Household expenditures on food in Holland", *J. R. Statist. Soc.*, A, **113**, 59–80.
673. SUITS, D. B. (1948), "Long-run and short-run changes in productivity and their effects on employment", *Papers Mich. Acad. Sci. Arts Letters*, **34**, 267–76.
674. THACKERAY, F. G. (1950), "Elasticity of demand for U.K. imports", *Bull. Oxf. Inst. Statist.*, **12**, 109–14.
675. TINBERGEN, J. (1949), "Some remarks on the problem of dollar scarcity", *Econometrica*, (suppl. July 1949), 73–97. English version of entry 487.
676. TINBERGEN, J., & POLAK, J. J. (1950), *The Dynamics of Business Cycles*. London: Kegan Paul.
677. TINTNER, G. (1950), "An econometric investigation of the British labor market", *Econometrica* (abstract), **18**, 268–9.
678. TINTNER, G. (1950), "Die Identifikation: ein Problem der Ökonometrie", *Statist. Vjschr.*, **3**, 7–12.
679. TINTNER, G. (1950), "Static econometric models and their empirical verification, illustrated by a study of the American meat market", *Metroeconomica*, **2**, 172–81.
680. TINTNER, G. (1950), "A test for linear relations between weighted regression coefficients", *J. R. Statist. Soc.*, B, **12**, 273–7.
681. TOBIN, J. (1950), "A statistical demand function for food in the U.S.A.", *J. R. Statist. Soc.*, A, **113**, 113–49.
682. TOLLEY, G. (1950), "Short run demand and supply in the hog market", *J. Farm Econ.*, **32**, 624–43.
683. VERHULST, M. J. (1950),"La fonction de coût de l'industrie du pétrole aux États-Unis entre les années 1936–1939 et 1941–1944", *L'industria*, **64**, 100–7.
684. VERHULST, M. J. (1950), "The theory of demand applied to the French gas industry", *Econometrica*, **18**, 45–55.
685. VINING, R. (1945), "Regional variation in cyclical fluctuation viewed as a frequency distribution", *Econometrica*, **13**, 183–213.
686. WANG, C.-H. (1950), "A note on farmers' consumption and its stabilizing nature", *Rev. Econ. Statist.*, **32**, 253–5.
687. WEINFELD, W. (1950), "Income of dentists, 1929–48", *Surv. Curr. Bus.*, **30**, No. 1, 9–16.
688. WILSON, R. (1947), *Facts and Fancies about Productivity*. Melbourne: Economic Society of Australia and New Zealand.
689. WINSTON, C., & SMITH, M. A. (1950), "Income sensitivity of consumption expenditures", *Surv. Curr. Bus.*, **30**, No. 1, 17–20.
690. WOLD, H. (1943–4), "A synthesis of pure demand analysis", *Skand. AktuarTidskr.*, **26**, 85–118, 220–63 and **27**, 69–118.
691. WOLD, H. (1949), "Statistical estimation of economic relationships", *Econometrica* (suppl. July 1949), 1–22.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

692. ZIPF, G. K. (1949), *Human Behavior and the Principle of Least Effort*. Cambridge, Mass.: Addison-Wesley.
693. ZIPF, G. K. (1950), "A note on brand-names and related economic phenomena", *Econometrica*, **18**, 260–3.
694. ZIPF, G. K. (1950), "Quantitative analysis of Sears, Roebuck and Company's catalogue", *J. Marketing*, **15**, 1–13.
695. (1950), "Consumer buying and credit developments", *Surv. Curr. Bus.*, **30**, No. 11, 11–3.
696. (1950), "Consumptiefuncties voor Nederland, 1923–1938", *Statist. Econ. OndZoek.*, **5**, 131–46.
697. (1950), "De prijsvorming van appelen en peren, 1923–1939", *Statist. Econ. OndZoek.*, **5**, 165–8.
698. (1950), "De verdeling van de inkomens boven f. 4000 in 1948", *Statist. Econ. OndZoek.*, **5**, 98–104.
699. (1949), *Pig Meat Production Costs*. Canberra: Bureau of Agricultural Economics, Dept. of Commerce and Agriculture.
700. (1949), "Regressionsanalyser av den svenska importen under mellankrigstiden", *Med. KonjInst.* (B), 56–72.
701. (1949), "Report on egg cost of production survey 1948–9", *Poultry Farmer*, **16**. Canberra: Bureau of Agricultural Economics, Dept. of Commerce and Agriculture.
702. (1950), "Retail sales", *Surv. Curr. Bus.*, **30**, No. 2, 21–3.
703. (1950), "The rise in business inventories", *Surv. Curr. Bus.*, **30**, No. 6, 3–4.
704. (1950), "1950 survey of consumer finances", Pts. 1–5, *Fed. Reserve Bull.*, **36**.

IV. *Economic Classification*

1. *Collection of Data Concerning Micro-Economic Behaviour*

(*a*) Family budget surveys

(625), (633), (660), 665, 704.

(*b*) Surveys of other economic units

617, (625), 630, 646, 699, 701.

2. *Estimation of Size Distributions*

(*a*) Income

(605), (610), 617, (633), 662, 698, 704.

(*b*) Wealth

(633), 704.

(*c*) Consumption

660.

(*d*) Production

662, 692, 694.

(*e*) Taxes

3. *Estimation of Social Accounting Aggregates*

(*a*) Income

(634), 646, (670).

(*b*) Wealth

646.

(*c*) Consumption

(634), (670).

(*d*) Production

(634), 646.

(*e*) Taxes

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

4. *Graduation, Reliability and Adjustment of Economic Data*

(*a*) Income

603, (606), 614, (615), 619, (623), 624, (650), 661, 685,698.

(*b*) Wealth

622.

(*c*) Consumption

(*d*) Production

616, 692, 693, 694.

(*e*) Taxes

5. *Demand Functions*

(*a*) Consumers' goods

(i) Consumption as a whole

608, 611, 613, 628, 629, (636), 640, 642, 649, 660, 672, (690), 695, 696, 702.

(ii) Particular goods

598, 599, 601, 602, 613, 628, 629, 631, 632, 637, 643, 653, 663, 668, 669, 681, 684, 686, 689.

(*b*) Producers' goods

642, 664, 703.

(*c*) Imports and exports

(626), 627, 639, 645, (647), (652), 655, 656, 658, 659, 674, 675, 700.

(*d*) Money and other assets: debts

657.

6. *Production, Cost and Supply Functions*

(*a*) Individual firms and industries

(i) Agriculture

600, 618, 654, 699, 701.

(ii) Other industries

641, (648), 683.

(iii) National or whole economy functions

644, 673, (680).

(*b*) Labour supply

604, 666, 667.

(*c*) Business size, profitability; number of firms

(*d*) Inter-industry input-output relationships

(612).

7. *Models of Particular Markets*

(*a*) Consumers' goods markets

681, 697.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(*b*) Producers' goods markets

(i) Agriculture
679, 682, 697.

(ii) Other

(*c*) Labour markets

621, 667, (677).

(*d*) International markets

675, 700.

(*e*) Financial markets

(*f*) Market structure and price determination

(*g*) Economic growth patterns

8. *Explanations of Distribution of Incomes*

(*a*) Functional

(*b*) Industrial

621, 641, 687.

(*c*) Regional

607, 609, 620, 641.

(*d*) Business financial policy

9. *Interrelations between Government and the Economy*
619, 635.

10. *Business Cycle Models*
(638), (651), 655, 656, 664, 671, 676, 685, 686.

11. *Other Economic Relationships*
675.

12. *Index Numbers*
(626), 688.

13. *Theoretical and Expository Articles on the Application of Mathematical Statistics to Economics*
638, 652, 678, 688, 691.

V. *Mathematical-Statistical Classification*

21. *Measurement of Economic Magnitudes by Sampling Methods*
610, 617, 625, 630, 633, 634, 646, 665, 670, 698, 704.

22. *Subjective Assessment of Errors of Observation and their Use in the Adjustment of Observations*

23. *Specification of Frequency Distributions of Economic Variables*
603, 606, 614, 615, 616, 619, 623, 624, 633, 650, 651, 661, 662, 685, 692, 693, 694, 698, 704.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

24. *Testing Hypotheses Concerning Economic Relationships, Estimation of Parameters and Prediction*

(*a*) Analyses of variance and co-variance

626, 638, 646, 660, 672, 680, 684.

(*b*) Other applications of classical regression

598, 599, 600, 601, 602, 604, 607, 608, 609, 611, 613, 618, 620, 621, 622, 627, 628, 629, 631, 632, 635, 637, 638, 639, 640, 641, 643, 644, 645, 649, 653, 654, 655, 656, 657, 658, 659, 660, 663, 664, 666, 667, 668, 669, 671, 672, 673, 674, 675, 676, 682, 683, 686, 687, 689, 690, 695, 696, 697, 700, 702, 703.

(*c*) Confluence analysis

638, 681.

(*d*) Simultaneous equations

618, 636, 638, 642, 677, 679, 681, 684.

(*e*) Autoregressive single equations

638.

(*f*) Other models

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Wholesale Prices in 1952

By the Editor of "The Statist"

Method of Construction of the Index Numbers

The following table illustrates the method of construction of the index numbers. The index numbers here given are based on the average prices for the eleven years 1867–1877. Take, for instance, the *Gazette* price of English wheat:

	s.	d.				
Average, 1867–77 . . .	54	6,	average point.			
,, 1914 . . .	35	0,	64 or 36 per cent.	*below*	the average point.	
,, 1930 . . .	80	7,	148 ,, 48 ,,	*above*	,,	,,
,, 1936 . . .	53	3,	98 ,, 2 ,,	*below*	,,	,,

The individual index numbers, therefore, represent simple percentages of the average point. The 45 articles are grouped in six categories. They are shown in detail in Table 5.

The general average is drawn from all 45 descriptions which are treated as of equal value, and is the simple arithmetic mean.

Table 1

Construction of Index Number for 1952

1867–77 = 100

	Number of Commodities in Index	*Total Numbers*		*Index for 1952*
		1867–77	1952	
General average	45	4,500	17,104	380
Food	19	1,900	5,588	294
Vegetable food	8	800	2,686	336
Animal food	7	700	1,996	285
Sugar, coffee and tea . . .	4	400	906	227
Materials	26	2,600	11,516	443
Minerals	7	700	3,727	532
Textiles	8	800	3,801	475
Sundry materials . . .	11	1,100	3,988	363

Table 2

Annual and Monthly Index Numbers

1867–77 = 100

	Year	*Jan.*	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
1902–1911 .	74	73·9	74·0	74·2	74·5	74·9	74·5	74·5	74·3	74·3	74·5	74·4	74·8
1912–1921 .	148	145·2	146·3	146·9	147·7	147·9	147·2	147·9	149·2	149·0	149·3	149·1	149·2
1922–1931 .	120	122·7	123·0	122·5	122·0	121·0	119·3	119·0	118·0	118·0	118·6	119·2	118·5
1932–1941 .	97	96·0	96·5	96·5	96·8	97·3	96·9	97·5	97·8	98·7	98·8	99·4	101·4
1942–1951 .	231	221·4	224·1	224·6	227·3	228·0	227·1	226·7	227·3	231·2	235·3	238·5	241·2
1943 . .	155	153·3	153·2	154·0	154·9	155·6	155·4	156·0	154·4	154·6	153·7	153·9	153·9
1944 . .	160	154·9	155·1	155·7	157·9	159·5	160·0	161·9	161·5	160·1	159·6	160·3	160·7
1945 . .	164	161·4	161·5	162·1	162·4	164·0	166·7	165·2	163·2	162·7	162·7	162·7	163·2
1946 . .	186	165·6	166·2	166·6	168·4	169·3	169·7	174·4	175·7	180·5	196·2	198·1	200·5
1947 . .	230	206·7	209·6	212·1	215·9	216·5	218·1	223·4	225·9	228·9	236·0	240·8	246·5
1948 . .	260	250·5	253·4	256·0	256·4	260·0	263·9	260·4	260·1	258·1	261·5	263·8	266·0
1949 . .	274	267·6	266·8	265·4	272·0	269·2	267·2	263·3	262·5	285·7	291·5	293·7	297·4
1950 . .	324	300·2	301·0	301·7	305·2	308·3	310·3	317·7	332·1	335·7	349·2	363·1	372·3
1951 . .	402	404·8	420·5	419·3	425·7	420·6	405·2	394·5	387·9	395·9	392·0	396·9	399·7
1952 . .	380	403·5	394·8	384·4	377·5	372·2	379·5	374·4	370·4	369·9	368·9	369·4	372·9

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Annual and Quarterly Index Numbers for Groups

1867–1877 = 100

	All Groups	Food				Materials			
		Total	Vegetable Food	Animal Food	Sugar, Coffee and tea	Total	Minerals	Textiles	Sundry Materials
1902–1911	74	71	66	88	49	77	90	70	74
1912–1921	148	146	136	167	100	154	166	151	148
1922–1931	120	115	101	150	80	122	137	128	110
1932–1941	97	88	84	116	49	103	131	94	91
1942–1951	231	172	201	169	121	273	300	306	232
1943	155	138	156	156	72	167	187	166	156
1944	160	137	152	156	73	178	197	182	161
1945	164	139	155	156	78	182	209	189	159
1946	186	140	155	154	88	219	239	231	198
1947	230	156	191	149	100	284	304	295	263
1948	260	171	217	155	107	324	368	348	279
1949	274	201	240	185	151	328	382	356	273
1950	324	235	268	204	224	390	416	491	299
1951	402	265	305	227	249	502	516	639	394
1952	380	294	336	285	227	443	532	475	363
1951 1st Quarter	414·9	252·9	295·0	210·1	243·9	533·2	527·5	749·8	379·2
2nd ,,	417.2	265·4	317·5	214·8	250·6	527·9	512·1	718·1	399·5
3rd ,,	392·8	276·6	314·9	245·1	251·9	475·9	507·5	565·3	390·9
4th ,,	396·2	280·8	321·4	249·9	250·9	480·8	521·7	562·3	395·6
1952 1st Quarter	394·2	284·0	324·7	259·7	244·2	475·3	550·0	523·9	392·6
2nd ,,	376·4	283·9	323·7	273·4	225·3	444·6	535·6	477·3	362·9
3rd ,,	371·6	293·6	322·5	300·8	226·3	428·6	536·2	448·4	345·9
4th ,,	370·4	302·6	332·9	313·5	225·5	420·1	513·2	441·8	344·9

TABLE 4

Monthly Index Numbers for Groups

1867–1877 = 100

	Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951													
Food:													
Total	265	251·7	253·9	253·2	261·0	265·7	269·5	275·4	276·6	277·3	277·8	278·9	285·8
Vegetable food	305	292·5	295·0	297·4	315·5	314·0	323·0	313·3	315·5	316·0	317·1	321·8	325·2
Animal food	227	210·1	210·1	210·1	210·1	216·2	216·2	245·1	245·1	245·1	245·1	245·1	259·6
Sugar, tea and coffee	249	243·0	248·4	240·3	241·3	255·5	255·1	250·0	251·8	253·8	254·0	249·3	249·3
Materials:													
Total	502	516·7	542·2	540·6	546·1	533·8	503·7	479·6	467·4	480·8	473·8	484·3	484·3
Minerals	516	520·2	538·6	523·6	523·9	523·1	489·4	485·4	513·5	523·6	522·4	523·1	519·6
Textiles	639	730·3	769·3	750·0	771·3	721·8	661·2	599·8	536·4	559·7	553·8	563·9	569·1
Sundry	394	359·1	379·4	399·2	396·5	403·9	398·2	388·6	387·8	396·2	384·6	401·9	400·2
1952													
Food:													
Total	294	285·9	282·9	283·1	280·1	277·7	294·0	290·5	293·9	296·3	300·1	302·8	304·8
Vegetable food	336	324·8	323·4	325·8	324·2	321·4	325·6	316·4	323·5	327·7	329·2	332·6	336·9
Animal food	285	259·7	259 7	259·7	259·7	259·7	300·8	300·8	300·8	300·8	313·5	313·5	313·5
Sugar, tea and coffee	227	251·1	243·4	238·1	228·5	223·4	224·0	225·2	225·2	228·5	221·3	227·2	227·9
Materials:													
Total	443	489·6	477·6	458·8	449·5	442·2	442·1	435·7	426·4	423·8	419·3	418·2	422·8
Minerals	532	540·9	558·3	550·7	543·3	523·0	540·4	539·5	533·5	535·5	509·2	509·3	521·1
Textiles	475	563·5	519·7	488·5	477·9	479·8	474·2	461·4	441·5	442·3	445·1	443·3	437·0
Sundry	363	403·4	395·6	378·7	369·3	363·4	356·1	351·1	347·2	339·3	343·2	341·9	349·7

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 5

Average Prices of Each of the 45 Commodities

1948 to 1952

		Average Prices					*Index Numbers* (1866–77 = 100)				
		1948	1949	1950	1951	1952	1948	1949	1950	1951	1952
Vegetable Food											
1 Wheat, English Gazette	*s.* and *d.* per qr.	90 0	99 6	110 8	122 10	129 0	165	183	203	225	237
2 American	,, ,, ,,	73 4	88 3	107 9	106 0	108 11	131	158	192	189	194
3 Flour, G.R.	*s.* per sack (280 lb.)	40	43½	52	56⅜	80¾	87	95	113	123	175
4 Barley, English Gazette	*s.* and *d.* per qr.	95 8	92 4	99 8	124 6	116 4	245	237	255	319	300
5 Oats, ,, ,,	,, ,, ,,	58 0	58 6	60 2	72 11	74 5	223	225	231	280	286
6 Maize, American mixed (*a*)	*s.* per qr.	43	72½	105½	127⅛	132¼	132	223	325	391	407
7 Potatoes, good English	,, ton	207	222	225	261	295	177	190	192	223	252
8 Rice, Rangoon cargoes to arrive	*s.* and *d.* per cwt.	57 6	61 0	63 0	69 0	83 6	576	610	630	690	835
Animal Food											
9 Beef, prime	*d.* per 8 lb.	79	103¼	114	125½	158	134	175	193	213	268
10 ,, middling	,, ,,	72	88⅝	96	107½	140	144	177	192	215	280
11 Mutton, prime	,, ,,	100	127¾	140	152½	190	159	203	222	242	301
12 ,, middling	,, ,,	81	92 13/16	98	100	111	147	169	178	182	202
13 Pork, large and small, average	,, ,,	99	127⅜	140	152⅜	190	190	245	269	293	365
14 Bacon, Waterford	*s.* per cwt.	154¾	159½	175¾	194	281½	209	216	238	262	380
15 Butter, Friesland, fine to finest	,, ,,	122¾	134⅛	168¼	230½	250	99	107	135	184	200
Sugar, Coffee and Tea											
17 Sugar, Java floating cargoes (*b*)	,, ,,	24⅛	26¼	40⅜	45⅜	33	85	92	142	159	116
18 Coffee, Ceylon plantation, low middling (*c*)	,, ,,	169	356	532	520½	471½	194	409	611	598	542
Rio, good	,, ,,	79	145	297¼	395	380	123	227	464	617	594
19 Tea, average import price	*d.* per lb.	32·21	33·72	37·37	39·42	38·36	187	195	217	228	222
Minerals											
20 Iron, Scottish pig	*s.* and *d.* per ton	194 5	228 11	239 6	252·1	291 10	} 300	336	348	367	424
Cleveland (Middlesborough) pig	,, ,, ,,	193 5	204 7	209 1	221·10	255 8					
21 bars, common	£ per ton	21¼	20	20	21⅞	26⅖	258	244	244	263	325
22 Copper, Standard	,, ,,	134	132¾	179	220⅝	260	179	177	239	294	347
23 Tin, Straits	,, ,,	547⅝	603½	744⅕	1,073⅞	964 9/16	521	575	709	1,023	919
24 Lead, English pig	,, ,,	97	104 1/16	111 5/16	163 9/16	135 9/16	473	508	543	798	661
25 Coal, Best Yorkshire House	*s.* per ton	54¾	54¾	53	58½	64 11/12	249	249	241	266	296
26 average export price	,, ,,	74·07	72·97	73·65	74·88	94·38	594	584	589	599	755

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 5—*cont.*

			Average Prices					Index Numbers (1866–77 = 100)				
			1948	1949	1950	1951	1952	1948	1949	1950	1951	1952
Textiles												
27	Cotton, Middling American	*d.* per lb.	23·23	24·85	36·15	46·01	38·92	258	276	402	511	432
28	East Indian	,, ,,	17·80	20·52	32·96	42·04	36·93	264	304	488	623	547
29	Flax, Medium grade continental retted	£ per ton	274	283¾	351	486	380½	598	562	689	968	737
	Belgian import price	,, ,,	281·3	244·3	296·7	424·3	312·3					
30	Hemp, Manila for roping	,, ,,	88⅓	105¾	144	183 7/12	130 5/16	396	363	435	547	527
	Italian S.B.	,, ,,	220	117⅞	195 7/12	243½	270¼					
31	Jute, Daisee ⅔	,, ,,	96 9/10	101½	112 7/16	168⅜	99⅞	510	534	593	886	526
32	Wool, Merino, Port Philip, average fleece	*d.* per lb.	92⅛	92⅜	157 7/16	177¼	120	492	506	821	912	621
	Merino, Adelaide, average greasy	,, ,,	61⅛	65	98⅛	106½	73					
33	English Lincoln half hogs	,, ,,	33	38⅜	65¾	99	49½	167	194	333	501	251
34	Silk, Japanese	*s.* per lb.	23 9/16	25¼	38 5/16	37⅛	36⅔	102	110	166	162	160
Sundry Materials												
35	Hides, River Plate, dry	*d.* per lb.	20 31/32	21 15/16	28 9/16	42¼	25¼	271	279	360	558	336
	River Plate, salted	,, ,,	20 5/16	20 7/16	26 13/16	38 1/16	20 9/16					
	average import price	,, ,,	20·72	21·43	27·08	47·27	30·96					
36	Leather, dressing hides	,, ,,	43⅜	45	58	80¾	62½	311	328	373	516	388
	average import price	,, ,,	64⅝	69 1/16	71 1/16	98⅜	72½					
	Tallow, Town	*s.* per cwt.	60	60	80⅛	109 5/16	86½	133	133	178	243	192
	Oil, palm	£ per ton	99¼	99¼	100 3/16	108⅝	106⅛	254	254	257	278	272
	olive	,, ,,	329	320	322	387	328¾	658	640	644	774	657
	linseed	,, ,,	193 15/16	149⅝	132 7/16	169	185	456	385	417	522	508
	Seeds, linseed	*s.* per qr.	216¾	197	243¼	301⅛	272					
41	Petroleum, motor spirit (c.i.f.)	*d.* per imp. gall.	9·38	9·61	11·67	12·66	13·30	59	60	73	80	84
	Kerosene (burning oil) c.i.f.	,, ,, ,,	8·74	8·51	10·55	11·41	12·58	138	135	167	181	199
	gas oil, c.i.f.	,, ,, ,,	8·69	7·78	9·84	11·19	11·84	218	195	247	281	297
42	Soda, crystals	*s.* per ton	107½	107½	107½	125	190	117	117	117	136	206
43	Sodium nitrate	*s.* per cwt.	19¾	20½	21¾	27⅜	30	141	146	155	195	214
44	Indigo, Bengal, good consuming	*s.* per lb.	7	7	7	9⅛	14	97	97	97	126	193
45	Timber, hewn, average import price	*s.* per load	215·02	207·09	228·33	367·83	376·00	498	493	534	806	829
	sawn, or split, average import price	,, ,,	352·82	354·37	380·46	550·31	569·24					

(*a*) Argentine maize (Feeding Stuffs) from 1941. (*b*) Raw centrifugals. 96 per cent. Pol,. from 1924. (*c*) East India, good middling from 1908–1947; Kenya from 1948.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 6

Index of Silver Prices

The base of the Index Numbers given below is 60·84*d.* per standard ounce = 100, this being a parity of 1 fine oz. of gold to 15½ standard ozs. of silver.

	Price per oz. Standard (d.)		*Index Number*	
	Average for year	*At end of December*	*Year*	*At end of December*
1942	23½	23½	18·1	18·1
1943	23½	23½	18·1	18·1
1944	23½	23½	18·1	18·1
1945	30½	44	23·1	31·1
1946	48⅝	55½	36·7	41·6
1947	44 7/16	45	33·3	33·8
1948	45	42½	34·1	31·9
1949	49⅕	64	32·8	33·3
1950	64⅘	70	33·7	36·4
1951	77 27/32	77	40·5	40·1
1952	74⅜	72¾	38·7	37·9

TABLE 7

Gold and Silver: Production

	Gold Value of output* (£ *thousand*)	*Silver* (*million ounces*)				
		Total	*United States*	*Mexico*	*Canada*	*Australia*	*Other Countries*
1902–1911	818,170	1,879·3	561·2	670·6	153·5	152·0	341·9
1912–1921	850,973	1,862·4	657·1	542·0	230·1	73·3	359·9
1922–1931	823,978	2,414·7	585·6	967·5	213·4	101·2	547·0
1932–1941	1,408,500	2,334·2	524·6	766·9	204·2	838·5	
1942–1951	1,096,400	—	376·2	563·0	176·4	—	
1942	146,300	..	54·5	84·9	21·8	71·8‡	
1943	113,200	..	44·8	71·2	18·6	59·3	
1944	103,300	..	37·4	63·0	14·8	57·7	
1945	98,400	..	29·3	61·1	14·0	46·4	
1946	99,900	..	21·4	48·3	13·6	47·1	
1947	101,400	..	36·1	49·2	13·5	44·6	
1948	103,100	..	36·1	45·8	17·0	46·0	
1949	109,400	..	34·6	49·5	17·6	44·3	
1950	112,200	..	42·0	49·0	22·5	44·2	
1951	110,500	..	40·0	43·8	23·0	37·0	
1952	112,200†	..	40·5	45·0	25·0	41·5	

* The value of gold is taken throughout at £4·25 per fine oz. † Provisional. ‡ Incomplete from 1942 onwards.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

Telecommunications Statistics*

By Arthur Hazlewood

This note is concerned with the sources of statistical information relating to the telephone and telegraph services operated in the United Kingdom, for both inland and overseas communication.

History of the Services

An outline of the organizational history of the services is useful as a background to a discussion of the statistical material.

The electric telegraph first came into practical use in the late 1830's and was developed by private companies to provide both internal and foreign communication. Dissatisfaction with the alleged high charges, poor service and inadequate development of the companies' systems led to Telegraph Acts of 1868 and 1869, which gave to the Postmaster-General power to purchase the companies' systems and a monopoly of inland telegraph business. Since February, 1870, the inland telegraph service has been operated by the Post Office.

The first telephone company in this country was established in 1878, and telephone exchange service was opened in the following year. A legal judgment in 1880 determined that the Postmaster-General's monopoly under the Telegraph Acts extended to the telephone. In return for a royalty payment, the Postmaster-General granted licences to provide telephone service to a number of companies, which soon amalgamated under the name of the National Telephone Company. The Post Office owned and operated the trunk telephone system from 1896, and provided local exchange service to a very small extent in the Provinces. For a time, after 1899, licences were granted to a number of municipal authorities to establish telephone systems, and the Post Office opened an exchange system in London in 1902. But the National Telephone Company was primarily responsible for telephone development in Britain until its system was taken over by the Post Office at the end of 1911. To-day, with the exception of municipal systems in Hull and the Channel Islands, the United Kingdom telephone service is in the hands of the Post Office.

The Telegraph Act of 1869 specifically excluded overseas telegraph communications from the monopoly of the Postmaster-General. These are now divided between the Post Office, which operates a European service, and the recently nationalized Cable and Wireless, Ltd. The Western Union Telegraph Company and a number of other companies also own telegraph cable routes over which traffic from this country to various parts of the world is conducted. The foreign telephone service is, of course, operated by the Post Office.

Statistical information on telephones and telegraphs refers to the financial year, ending March 31st, but there have been exceptions to this in the past.

Size of the System and Traffic

Statistics of services such as the telephone and telegraph relate either to the size of the system or to the use made of it.

The number of telephones connected, often referred to as the number of stations, is an important but not the only measure of the size of a telephone exchange system. In addition it is of interest to know the number of subscribers and the number of direct exchange lines, since a single exchange line may have a number of extension telephones available for connection to it, and some subscribers have many lines. A different charge is made for telephones at private residences from that levied on business users, so the total numbers of telephones and lines can be subdivided

* Thanks are due to Mr. E. C. Baker, Post Office Librarian and Archivist, for making library facilities available during the preparation of this note.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

into those for business and those for residential subscribers. In a telephone system having some exchanges of the automatic type and others manually operated, distinction can be made between lines and stations connected to automatic exchanges and those connected to manual exchanges. Public call office and private-wire telephones can also be distinguished. A further indication of the extent of a telephone system is given by the total length of lines. This is generally measured on the basis of mileage of single wire, classified as overhead, underground, or submarine.

The use of a telephone system, or the traffic, is measured by the number of completed calls made. These can be distinguished as trunk calls or local calls, the former being either inland or international. The distinction between trunk and local calls is a formal one, depending on the tariff policy of the service, and may change from time to time. For example, in May, 1936, certain calls which had previously been counted as trunk calls were reclassified as local. On the old basis the number of trunk calls made in 1935–6 was 97·7 mn., whereas under the new classification it would have been 88·3 mn.

The extent of a telegraph system is usually indicated by the number of telegraph offices at which telegrams are accepted for transmission, but with the possibility of using the telephone for verbal transmission of the message to the telegraph centre this measure would seem to lose much of its significance. Telegraph traffic is commonly measured by the number of telegrams or messages transmitted, though for international traffic the number of words is sometimes used. Telegrams may be classified according to the character and subject-matter of the message (social or business, of various kinds), their length and the distance sent. Information of this type, though not regularly compiled, can be important in suggesting the scope for stimulating traffic by new facilities and tariff changes. An analysis of a census of telegraph traffic carried out during one week of 1934 has been published by the Post Office. Classes of traffic usefully distinguished in this country are press telegrams, which are transmitted at special cheap rates, the subject of much controversy at different times, and certain railway messages, which are transmitted free under an agreement made when the Post Office, by the Telegraph Act of 1868, took over the public telegraph business conducted by the railway companies.

An annual Parliamentary Paper, the *Post Office Commercial Accounts*, has published non-financial statistics of the Post Office services since 1929–30. For the telephone it now gives most of the information referred to above. Telegraph inland traffic is classified as Government and Non-Government Ordinary Telegrams, Press Telegrams, and Railway Pass Telegrams. Overseas telegrams are divided between those which the Post Office transmits (Irish Republic Service; European Service; Service with Ships at Sea), and those for which the Post Office acts only as an intermediary between the public and the cable company responsible for the transmission or reception of the messages. A less detailed presentation of these data appears in the *Annual Abstract of Statistics*.

Since the telephone and telegraph services operate over the same cables, figures of wire mileage are for telephones and telegraphs together. More detailed statistics of wire mileage than are given in the *Commercial Accounts* are available periodically in *The Post Office Electrical Engineers' Journal*. These show the distribution of the total mileage between trunk, junction, and local lines, as well as between the eight Regions in which the Post Office services are now organized.

Much of the overseas telegraph traffic is not handled by the Post Office at any stage, and so is not included in the Post Office statistics. Information on this traffic is furnished to the International Telecommunication Union and is published in its *General Telegraph Statistics*. The *Accounts and Report of Directors* of Cable and Wireless appears as a Command Paper which gives a few statistics of traffic in terms of telegraph words handled. Until the war, Cable and Wireless issued a monthly index-number of receipts from traffic, related to comparable traffic in 1929, but this has not been revived.

A great deal more detailed information than is published appears in *Post Office Telecommunications Statistics* ("Orange Book"), issued, for limited circulation, in March, 1949, with supplements to date. This summarizes the principal statistics over a period of years, in some cases back to 1913. It shows the total number, subdivided into various categories, of exchange lines and stations, together with the annual increase, both gross and net (i.e., additions less cessations). Details are given of telephone and telegraph traffic (number and type of telephone calls and telegrams), telephone exchanges, trunk circuits, and spare plant. Perhaps the most interesting information not available elsewhere relates to "quality of telephone service". Figures, based on

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1

The Telephone Service

	1938–39	*1946–47*	*1947–48*	*1948–49*	*1949–50*
Number of Stations March 31st (thous.)	3,235	4,319	4,653	4,919	5,171
Business Rate	59%	60%	60%	61%	61%
Residence Rate	37%	36%	36%	36%	36%
Call Offices, P.O. Service, Private Wires	4%	4%	4%	3%	3%
Number of Direct Exchange Lines March 31st (thous.)	2,047	2,636	2,836	2,952	3,032
On Automatic Exchanges	55%	65%	66%	67%	68%
On Manual Exchanges	45%	35%	34%	33%	32%
Number of Inland Trunk Calls (mn.)	112	205	217	226	235
Number of Local Calls (mn.)	2,123	2,509	2,681	2,820	2,940
Number of Exchanges March 31st—					
Automatic	2,925	3,725	3,835	3,969	4,091
Manual	2,790	2,058	1,979	1,879	1,775
Mileage of single wire (telegraph and telephone) March 31st (thous.)					
Overhead	1,481	n.a.	1,933	1,894	1,927
Underground	13,793	n.a.	22,991	24,097	24,946
Submarine	25	n.a.	44	43	43

Source: *Post Office Commercial Accounts.*

TABLE 2

The Telegraph Service

	1938–39	*1946–47*	*1947–48*	*1948–49*	*1949–50*
Number of Inland Telegrams (thous.)	50,395	52,718	47,439	43,396	41,974
Ordinary Non-Government	94%	94%	96%	95%	95%
Inland Press, Railway Pass, and Government	6%	6%	4%	5%	5%
Number of Overseas Telegrams (thous.)	7,889	10,627	10,615	10,265	10,490
Accepted or delivered for Cable Companies	17%	36%	32%	32%	31%
Other	83%	64%	68%	68%	69%
Total Telegraph Traffic handled (thous.)	58,284	63,345	58,054	53,661	52,464

Source: *Post Office Commercial Accounts.*

samples, are given of the percentage of calls not completed at the first attempt, and of the proportion of these failures caused by the called telephone being unanswered or engaged, for which the Post Office is not responsible. Average time of answering is given for manual exchange and trunk telephone service, and for the latter the average time to complete the connexion is shown.

For Official use *Inland Telecommunications Department Statistics* gives yet more detailed data, including such information as the distribution of telephone trunk traffic between the reduced and full-rate periods. Many of these statistics are separately shown for the various Regions into which the Post Office services are organized.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Telephones : Quality of Service

Automatic Exchanges: *Director Exchanges (i.e., big cities)*	*Percentage of Calls Completed First Attempt*	*Failure due to—*	
		P.O.	*Subscriber*
1938–39	77·3	8·0	14·7
1939–40	77·6	8·2	14·2
1945–46	71·0	8·9	20·1
1946–47	71·7	8·1	20·2
1947–48	71·6	7·7	20·7
1948–49	72·8	7·2	20·0
1949–50	73·4	6·5	20·1
Non-Director Exchanges:			
1938–39	85·9	2·0	12·1
1939–40	87·0	2·1	10·9
1945–46	83·1	3·2	13·7
1946–47	81·0	3·6	15·4
1947–48	78·3	4·8	16·9
1948–49	79·6	4·1	16·3
1949–50	79·5	3·9	16·6

Source: *Post Office Telecommunications Statistics.*

TABLE 4

Telephone Exchange Lines

	Gross New	*Gross Ceased*	*Net Increase*	*Ratio of New to Ceased*
1938–39 . . .	266,884	150,444	116,440	1·8 to 1
1946–47 . . .	506,219	206,768	299,451	2·4 to 1
1947–48 . . .	401,742	201,927	199,815	2·0 to 1
1948–49 . . .	341,064	224,206	116,858	1·5 to 1
1949–50 . . .	374,073	294,375	79,698	1·3 to 1

Source: *Post Office Telecommunications Statistics.*

SOURCES OF EARLY STATISTICS

The *Report of the Postmaster-General*, published annually till 1915–16 (the 62nd of the series), gave many statistics of the Post Office telephone and telegraph systems. From these Reports the growth of the Post Office trunk network and of the Provincial and London telephone exchange systems can be traced. The volume of telegraph traffic of various classes and in different regions of the United Kingdom is shown, together with financial information also obtainable in the separately published Accounts. Less detailed information is available in the *Statistical Abstract of the United Kingdom* for the Post Office telegraph system since 1870 and for the telephones since 1891–2. Statistics on the early development of the Post Office telephone service are given in a number of *Returns of Post Office Telephone Exchanges*. Reports of Select Committees in 1895 and 1905, Baldwin's *The History of the Telephone in the United Kingdom* and *Garcke's Manual of Electricity Undertakings* are sources of statistics on the telephone systems of the companies, the municipalities, and the Post Office. Statistics relating to the telegraph companies are available in a variety of Parliamentary Papers, and in articles in the *Journal of the Statistical Society* and the *Journal of the Society of Telegraph Engineers*, some of which are listed in the Bibliography. *The Electric Telegraph*, by D. Lardner, and *The British State Telegraphs*, by H. R. Meyer, are also

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

useful. Statistical information on the telegraph and telephone has been frequently reported in *Hansard*.

A great deal of material on the early history of the telegraph and telephone systems is contained in the Post Office archives. A guide to this collection will eventually be produced.

TABLE 5

National Telephone Company System 1895

593 exchanges.
75,216 subscribers' lines.
86,032 telephones.
139,639,032 calls p.a.

Source: *Report from Select Committee on the Telephone Service*, 1895.

TABLE 6

Post Office Provincial Telephone Exchanges

December 31st	*Number of Subscribers*
1896	1,151
1897	1,155
1898	1,213
1899	1,259
1900	1,548
1901	2,420

Source: *Returns of Post Office Telephone Exchanges*

TABLE 7

Post Office Trunk Telephone System

Year Ending March 31st	*Number of Trunk Circuits*	*Number of Trunk Calls (mn.)*
1898	877	5·9
1903	1,309	11·6
1908	2,385	22·0
1913	3,368	36·1

Source: *Reports of Postmaster-General.*

TABLE 8

Number of Inland Telegrams (millions)

1888–89	53·0	1913–14	75·6	1934–35	35·3
1893–94	65·2	1918–19	77·5	1935–36	44·5
1898–99	80·1	1923–24	53·6	1936–37	49·3
1903–04	82·2	1928–29	44·1	1937–38	49·2
1908–09	75·4	1933–34	36·2	1938–39	50·4

Source: *Statistical Abstract of the United Kingdom.*

INTERNATIONAL AND COMPARATIVE STATISTICS

Since 1912 the American Telephone and Telegraph Company has issued annually *Telephone Statistics of the World*, extracts from which are published in the *Bell Telephone Magazine*. The

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

details reported for many countries include the total number of telephones, the number for each hundred of the population, and the proportion of the total connected to automatic exchanges. Figures are also given for certain important towns. The 1950 issue shows that the United Kingdom has the second largest telephone system in the world in terms of number of telephones, but is only 9th, among those countries having in total more than 100,000 telephones, in terms of telephones per head of population.

The International Telecommunication Union, now a United Nations "specialized agency", produces *General Telegraph Statistics* and *General Telephone Statistics*, which give data on the telegraph and telephone systems of a large number of countries, including the United Kingdom.

Employment

The Post Office Estimate sets out the numbers of staff by grade and rank in great detail, but there is no classification of employment according to service. Engineering employment, however, is separately listed. *Inland Telecommunications Department Statistics* gives employment figures for Telephonists and for Engineering Workmen.

Tariffs

Charging for telephone service was originally on a flat rate basis—a rental payment for an unlimited number of calls. £20 p.a. was common for many years, later being reduced to £10 p.a. This method gradually gave way to measured, or message rate tariffs, consisting of a rental plus a payment according to the number of calls made. Trunk calls were charged according to duration and distance, and in 1903 a cheap rate for night trunk calls, which has become a standard feature of the service, was introduced. It was not till 1920 that the flat rate tariff for exchange service was finally abolished, the general level of charges being raised at the same time to meet the increased costs of the period. In the years following charges were lowered, particularly noteworthy reductions being made in 1934 and 1936, but the war and post-war years have been characterized by general increases. The telegraph companies charged according to distance, the rate in 1870 being 20 words for 1*s.* up to 100 miles, 1*s.* 6*d.* up to 200 miles, and 2*s.* for greater distances, generally with extra charges where the wires of more than one company were required. The Post Office, when it took over from the companies, charged 1*s.* for 20 words irrespective of distance, and in 1885 a sixpenny tariff was introduced, which lasted till 1916. 1935 saw the re-introduction of the sixpenny telegram, which continued until charges were raised in 1940.

Details of Post Office telephone and telegraph charges are obtainable from the *Post Office Guide*, published since 1856. Information on charges for the telegraph service first appeared in 1873 and for the telephone in 1881. The principal changes in the tariffs since 1919 are listed in *Post Office Telecommunications Statistics*. Company and Municipal telephone tariffs are quoted by Baldwin, *The History of the Telephone in the United Kingdom*, and in the *Report from the Select Committee on the Telephone Agreement*, 1905, and *Garcke's Manual of Electricity Undertakings* has some information. The *Report of the Departmental Committee on Telephone Rates*, 1920, outlines the history, to that date, of Post Office tariffs, while a brief account of telegraph tariff history is given in the 1895 *Report of the Postmaster-General*.

Financial Statistics of the Post Office Systems

The primary source of financial statistics is the *Post Office Commercial Accounts*, issued annually as a Parliamentary Paper. In addition to a set of general accounts for the Post Office as a whole, accounts are presented for the constituent Post Office services drawn up on a commercial basis, making full allowance, on the income side, for services rendered without payment to other Government Departments, and, on the expenditure side, for such items as depreciation and interest on capital. These give a clear picture of the financial position of both the telephone and telegraph services. Accounts have been presented in this form since 1912–13, when changes were instituted as a result of proposals by a Telephone Finance Committee. Before that year, and since 1907–08, "Accounts of Revenue and Deficiency in respect of Post Office Telegraphs and of Revenue and Capital in respect of Post Office Telephones", nominally on commercial

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

principles, had been published. But these were unsatisfactory in a number of ways. Proper allowance was not made for the value of services rendered by the Post Office to other Government Departments, and by those Departments to the Post Office; the actual amount spent on renewals in a given year was charged against revenue instead of an annual payment into a depreciation fund; revenue was charged with the actual amount paid out for pensions in a given year,

TABLE 9

Telegraph and Telephone Finances
(£ *million*)

	Telegraph Service		*Telephone Service*	
	Income	*Surplus or Deficit (−)*	*Income*	*Surplus or Deficit (−)*
1912–13	3·2	−1·2	5·8	0·3
4	3·1	−1·2	6·2	0·2
5	3·4	−1·2	6·5	−0·1
6	4·5	−0·5	7·1	−0·1
7	4·8	−0·5	8·5	0·2
8	5·4	−0·6	10·2	0·4
9	5.8	−0·7	10·5	−0·01
1919–20	6·1	−2·6	10·2	−2·0
1	5·8	−3·7	9·5	−4·7
2	5·9	−3·0	13·7	−0·6
3	5·5	−1·7	14·0	0·9
4	5·2	−1·3	14·6	1·6
5	5·1	−1·6	15·0	0·5
6	5·2	−1·3	16·2	0·6
7	5·1	−1·3	17·5	0·3
8	5·0	−1.4	18·9	0·1
9	5·1	−0·8	20·3	0·5
1929–30	5·0	−0·8	21·9	0·5
1	4·4	−1·0	22·8	0·3
2	4·2	−0·8	23·6	0·6
3	3·9	−0·8	24·4	0·4
4	3·9	−0·7	25.9	1·4
5	3·9	−0·7	27·0	1·7
6	3·8	−0·8	28·9	2·1
7	4·0	−0·6	31·0	1·5
8	4·0	−0·7	32·6	0·4
9	3·9	−0·8	34·6	0·3
1939–40	4·5	−0·6	38·9	1·0
1*		−0·4		3·6
2*		−0·3		7·8
3*		−0·1		12·4
4*		−0·2		18·7
5*		−0·1		23·1
6*		−0·04		20·6
7*		−1·9		14·1
8	6·9	−2·5	79·7	10·5
9	6·5	−3·9	82·3	8·1
1949–50	6·4	−4·4	89·1	9·1

Source: *Post Office Commercial Accounts.*

* Figures of telegraph and telephone income during these years are given in *Post Office Telecommunications Statistics.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

not with an annual payment into a pension fund, and interest on capital was not accurately charged. Earlier still, the accounts treated the telephone as part of the telegraph, and they failed properly to distinguish capital and current expenditure. Since 1913, then, it is possible to present the financial out-turn of the telephone and telegraph services. *Post Office Commercial Accounts* was not published during the war, and only approximate accounts were compiled for official use, so that the figures of surplus and deficit shown for this period are approximations. A less exact division of expenditure between the services was also made during these years, and this may have particularly affected the telegraph account.

With regard to the telephone service the heavy losses following the first World War are noteworthy. These were the result of high post-war costs, and were overcome by the combined effect of increased charges and a decline in costs. The high profits in the few years from 1934 were mainly due to the existence of a large amount of spare plant, so that increased business did not involve proportionately increased expense. Later, increased investment raised interest and depreciation costs so that the surplus diminished, and it was further affected by the rate reductions of 1934 and 1936, a statistical analysis of the effect of which may be found in *The Post Office Electrical Engineers' Journal* for October, 1939. The large war-time profits resulted from increases in both traffic and charges, but as further investment is carried out at high post-war costs, the surplus will fall. Statistics on this and other aspects of the post-war telephone situation are presented in an article in *The Post Office Electrical Engineers' Journal* for January, 1948.

In contrast with the financial success of the telephone is the telegraph with its continual losses. "It is in the unfortunate position of lying between the upper and nether millstones", as the *Bridgeman Report* put it, of the telephone and postal services. The deficit was considerably reduced after reorganization arising from the *Report of the Hardman Lever Committee* in 1927, but since the war it has again become very heavy. The re-introduction of a sixpenny telegram in 1935 led to a very great increase in traffic, as can be seen from Table 8, but Table 9 indicates that there was no significant effect on the size of the telegraph income or deficit.

TABLE 10

Public Telephone Call Offices
(*Average Receipts per Call Office*)

	£	*s.*	*d.*
1938–39	43	19	4
1946–47	91	12	5
1947–48	92	15	8
1948–49	94	3	6
1949–50	94	18	2

Source: *Post Office Telecommunications Statistics.*

In addition to income and expenditure accounts, the *Commercial Accounts* contains an account of the (notional) depreciation fund and a balance-sheet for both the telephone and the telegraph services.

The telephone income and expenditure account distinguishes the main sources of income—rentals, trunk call fees, and local call fees—and the division, for each of these, between subscribers, Government Departments and public call offices. The main distinctions made on the expenditure side are operating and administrative expenses, maintenance of the system (each subdivided into the contributing items, such as "Salaries, Wages, and Allowances" and "Materials and Freight"), accommodation (total Post Office accommodation costs being allocated between the constituent services on the basis of estimated division of user), pension liability, depreciation provision, and interest on capital. Similar distinctions, where appropriate, are made in the income and expenditure account of the telegraph service.

The *Commercial Accounts* also presents statements of Post Office capital which is raised, by Act of Parliament, on the security of Terminable Annuities. The great bulk of capital expenditure is on telephone plant, other items being sites and buildings, and plant for the telegraph service, the Post Office (London) Railway, and for light, heat and power. The division of the year's

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

capital expenditure between these items is indicated, but it should be noted that this is based on the figures given in the Appropriation Account, and is not directly comparable with the amounts derivable from the balance-sheets for the telephone and telegraph services. Since the war capital expenditure has been restricted to an amount far smaller than that necessary to meet the demand for telephone service. The permitted expenditure is set down in the *Economic Survey* for 1949 and for 1950. These figures include expenditure on renewals and repairs which is covered by Vote, so they are larger than the Appropriation Account figures of loan expenditure. The *Commercial Accounts* also lists the amounts authorized and raised under the various Acts, the total amounts expended on capital account in each year, and a schedule of the repayment of loan capital, together with the amounts outstanding, in each of the previous thirty years.

TABLE 11

Post Office Capital Expenditure

	1947–8	*1948–9*	*1949–50*
	£	£	£
Sites and Buildings . . .	782,784	2,346,093	2,711,380
Plant:			
Light, Heat and Power . .	321,370	561,386	738,125
P.O. (London) Railway . .	4,258	5,691	3,136
Telegraph	150,851	289,713	287,837
Telephone	20,379,578	22,338,675	27,081,194
	£21,638,841	£25,541,558	£30,821,672

Source: *Post Office Commercial Accounts* (derived from Appropriation Account; not directly comparable with balance sheet figures).

As a Department of State, in addition to its accounting on a commercial basis to show its position as a trading concern, the Post Office is included in the normal system of government accounting. This is conducted essentially on a cash basis, and its primary function is to ensure Parliamentary control. Much of this accounting treats the Post Office as a whole, but there is also useful information on the separate services. From the viewpoint of the telecommunications services the documents of interest are the *Estimates for Revenue Departments*, the *Revenue Departments Appropriation Accounts*, and the *Finance Accounts of the United Kingdom*.

All Post Office expenditure is made with money paid out of the Exchequer under the authority of Parliament, and all Post Office revenue is paid into the Exchequer. The Post Office Estimate states in great detail the estimated financial requirements of the Post Office in the future year to which it refers. The Appropriation Account records the sums actually paid out, together with an explanation of any divergence from the amount estimated. The *Finance Accounts* details the receipts of the various Post Office services and of the revenue paid into the Exchequer.

The Appropriation Account gives useful information on the distribution of both current (Vote) and capital (Loan) expenditure on the telecommunications services. Telecommunications expenditure as a whole is not separately listed, but engineering expenditure is covered by three sub-heads (Engineering Establishment, Engineering Materials, and Engineering Contract Work). The great bulk of this expenditure is on the telecommunications services, though some, such as motor transport, is applicable to the postal service.

TABLE 12

Post Office Engineering Expenditure

(£ *Thousand*)

Subhead		*1939*	*1949*
I	Engineering Establishment	7,366	19,506
K	Engineering Materials	2,424	10,472
L	Engineering Contract Work, etc. . . .	1,675	2,543

Source: *Revenue Departments Appropriation Accounts.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

An appendix to the Appropriation Account rearranges the information given in the body of the account to show the distribution of engineering expenditure between various purposes. The allocation is made for capital expenditure, on extensions of the system, as well as for Vote expenditure on maintenance and renewals. The distribution of capital expenditure has been shown in the Appropriation Account since 1927–8, while that of Vote expenditure is of longer standing. Until 1929 telegraph and certain other construction work, now provided out of loans, was covered by Vote expenditure.

The Appropriation Account also contains an Account of Stores in Stock (omitted during the war years) and a Loan Expenditure Account.

TABLE 13

Some Items of Expenditure on Engineering Works (Vote and Capital) and on Sites and Buildings (Capital)
(£ *Thousand*)

	Year ended March 31st			
	1939		*1950*	
	Vote	*Capital*	*Vote*	*Capital*
Trunk Lines	303	5,078	1,150	5,760
New Exchanges and Extensions	1,029	4,041	1,287	7,437
Local Lines	1,604	5,086	4,945	6,372
Subscribers' Circuits	1,127	3,092	3,064	7,027
Telegraph and Telephone Maintenance	5,581	—	14,869	—
Repair of Stores in Factories	459	—	1,017	—
Sites and Buildings	—	3,752	14	2,891

Source: *Revenue Departments Appropriation Accounts.*

The Post Office Estimate has an appendix showing the estimated value of telephone and telegraph service provided for other Government Departments. Until 1922–3 such service was provided free, but in that year other Departments, with minor exceptions, were made to pay cash for their use of the telegraph, the amounts required being included in their Estimates, and this system was extended to the telephone in the following year. In 1943–4 the cash payment system was suspended and has not yet been reinstituted. Although, of course, allowance is made for this service in the Commercial Accounts, in the cash accounts the only reference is in an appendix to the Post Office Estimate giving estimated Government user in the coming year. The effect is to reduce Post Office cash receipts, as shown in the *Finance Accounts*, relatively to the expenditure shown in the Appropriation Account, and by a similar amount to reduce the Estimates and Appropriations of other Departments. As a result the Post Office has an "excess of net payments over Revenue collected" which amounted to about £6¼ millions in 1949–50. The Select Committee on Estimates in 1950 recommended a return to cash payments, but the Treasury has decided that the present system shall continue for 1951–2. In view of the frequently expressed opinion that this system greatly encourages extravagant use of telephone facilities by Government Departments, it is worth while to list the amounts involved and the Departments mainly responsible. The telephone Commercial Account shows that, in 1949–50, Government Departments were

TABLE 14

Estimated Government User of Telephone Services
(£ *Thousand*)

	1947–48	*1948–49*	*1949–50*	*1950–51*	*1951–52*
All Departments	9,934	10,011	11,902	11,754	12,024
War Office, Air Ministry, Admiralty	52%	60%	65%	64%	66%
Ministry of Supply	10%	9%	7%	7%	7%

Source: *Estimates for Revenue Departments.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

responsible for 4 per cent. of the income from local call fees, almost 12 per cent. of that from trunk call fees, and not far short of one-quarter of the income from rentals, the greater part of this latter amount being for private wires. Further statistics are given in Annex 3 to the *Fourth Report from the Select Committee on Estimates*, 1950.

The Post Office Estimate for 1951–2 contains, for the first time, an estimate of the financial results on a Commercial Account basis and a reconciliation with the cash estimate. It will be interesting to observe the accuracy of the estimates of surplus and deficit for the telephone and telegraph services. It is worth recalling that in 1949, in the House of Commons, it was stated that the telephone surplus for 1948–9 and 1949–50 was expected to fall to £6 mn. and £3 mn. respectively, whereas, in the event, it was more than £8 mn. in the first, and over £9 mn. in the second of these years.

On the recommendation of the Committee on the Form of Government Accounts (Cmd. 7969), *Post Office Commercial Accounts* for 1949–50 includes a statement giving a reconciliation between the cash and Commercial Account figures for the Post Office as a whole.

CONCLUSION

Although the Post Office is organized on a regional basis, there is no reflection of this in most of the published statistics. Indeed, it is a general weakness of the available data that they are too much on an "overall" basis. Not only would a regional division of statistical material be enlightening, but the financial position of various parts of the telecommunications services could with advantage be distinguished. On the income side the revenue from local calls, trunk service, etc., is separately set out, but there is no attempt to strike a balance for the various parts of the service. A good many years ago separate accounts for local exchange and for trunk service were presented, and this practice could usefully be reintroduced. Until 1939–40 separate accounts were given for the Post Office overseas telephone and telegraph services, but these are no longer published. It would also be interesting to have some information on the financial position of public call offices and of rural as compared with urban telephone service.

BIBLIOGRAPHY

ANDERSON, Sir J. (1872), "Statistics of telegraphy", *J. R. Statist. Soc.*, **35**, 272.

BALDWIN, F. G. C. (1925), *The History of the Telephone in the United Kingdom*. London: Chapman & Hall.

BARNETT, B. L. (1948), "Post-war telephone developments", *P.O. Elec. Eng. J.*, **40**, 145.

Bell Telephone Magazine (1921, onwards). New York: American Telephone and Telegraph Co.

CLARK, L. (1875), "Inaugural address", *J. Soc. Telegraph Eng.*, **4**, 1. (Afterwards *J. Inst. Elec. Eng.*)

Garcke's Manual of Electricity Undertakings (1896, onwards). London: Electrical Press Ltd.

GRAVES, E. (1880), "A decade in the history of English telegraphy", *J. Soc. Telegraph Eng.*, **9**, 249. (Afterwards *J. Inst. Elec. Eng.*)

International Telecommunication Union, Geneva (1931, onwards), *General Telegraph Statistics*.

—— (1931, onwards), *General Telephone Statistics*.

LARDNER, D. (1855), *The Electric Telegraph Popularised . . .* London: Walton & Maberly.

MEYER, H. (1907), *The British State Telegraphs*. New York: Macmillan.

Telephone Statistics of the World (1912, onwards). New York: American Telephone and Telegraph Co.

TOWNSHEND, H. (1939), "The financial effect of recent reductions in telephone charges (inland service)", *P.O. Elec. Eng. J.*, **32**, 165.

United Kingdom: Central Statistical Office (1948, onwards), *Annual Abstract of Statistics*, No. 84, onwards. London: H.M.S.O.

United Kingdom: Parliament (1946–1947, onwards), *Cable and Wireless Limited: Accounts together with the Report of the Directors*. London: H.M.S.O.

—— (1950), *Fourth Report from the Select Committee on Estimates*. London: H.M.S.O.

—— (1909, onwards), *Parliamentary Debates (Hansard) . . .* London: H.M.S.O

—— (1920), *Report of the Departmental Committee on Telephone Rates*: XXV. London: H.M.S.O.

—— (1905), *Report from the Select Committee on the Telephone Agreement*: VII. London: H.M.S.O.

—— (1895), *Report from the Select Committee on the Telephone Service*: XIII. London: H.M.S.O.

—— (1867–1868), *Reports to the Postmaster-General by Mr. Scudamore*: XLI. London: H.M.S.O.

—— (1900), *Return of Post Office Receipts from the Telephone*: XLVII. London: H.M.S.O.

—— (1870), *Return of Telegraph Clerks, &c.*: XLI. London: H.M.S.O.

—— (1898), *Return showing for each year since the Purchase of the Telegraphs, the Revenue, Expenditure, and Net Revenue of the Post Office Telegraphs*: LII. London: H.M.S.O.

—— (1897, 1898, 1899, 1902), *Returns of Post Office Telephone Exchanges*: 1897, LII; 1898, LII; 1899, LXXVIII; 1902, LV. London: H.M.S.O.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

United Kingdom: Parliament (1860), *Returns Relating to Electric Telegraph Companies*: LXII. London: H.M.S.O.
—— (1873), *Returns Relating to Electric Telegraph Companies (Purchase)*: XXXIX. London: H.M.S.O.
—— (1867–1868), *Returns Relating to Electric Telegraphs*: XLI. London: H.M.S.O.
United Kingdom: Post Office (Jan. 1949, onwards), *Inland Telecommunications Department Statistics*. London: General Post Office, Inland Telecommunications Department (Operational Branch).
—— (1908, onwards), *Post Office Commercial Accounts* . . . London: H.M.S.O.
—— (1856, onwards), *Post Office Guide*. London: H.M.S.O.
—— (1935, onwards), *Post Office Telecommunications Statistics*. London: General Post Office, Inland Telecommunications Department (Operational Branch).
—— (1855–1916), *Report of the Postmaster-General* . . . London, H.M.S.O.
—— (1935), *Telegraph Census*. London: H.M.S.O. (Post Office green papers no. 14).
United Kingdom: Treasury (1872–1873, onwards), *Estimates for Revenue Departments* . . . London: H.M.S.O.
—— (1836, onwards), *Finance Accounts of the United Kingdom* . . . London: H.M.S.O.
—— (1923, onwards), *Revenue Departments: Appropriation Accounts* . . . London: H.M.S.O
WILLIAMS, R. P. (1881), "The question of the reduction of the present postal telegraph tariff", *J. Roy. Statist. Soc.*, **44**, 1.

A NOTE ON RECENT DEVELOPMENTS

In the House of Lords on June 26th, 1952, the Postmaster General announced that he had been able to persuade the Treasury to agree to certain Government Departments paying cash for their telephone service. The Departments concerned were the Ministry of Defence, the three Service Departments, the Ministry of Supply and the Treasury. Appendix E to the Post Office Estimate for 1953–4 notes that these Departments are to pay for their telegraph and telephone services from April 1st, 1953.

The estimate on a Commercial Account basis given in the Post Office Estimate for 1951–2 showed a telegraph deficit of £4·7 mn. and a telephone surplus of £6·6 mn. *Post Office Commercial Accounts* for 1951–2 shows the actual result to have been a deficit of £3·4 mn. for telegraphs and a surplus of £4·3 mn. for telephones. There had been changes in tariffs and in costs, and a transfer of certain services to telegraphs both from telephones and from Cable and Wireless.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—*Brookes* (*B. C.*). Notes on the Teaching of Statistics in Schools	203
2.—*Goulden* (*C. H.*). Methods of Statistical Analysis (2nd ed.)	204
3.—*Freund* (*J. E.*). Modern Elementary Statistics	205
4.—*McKinsey* (*J. C. C.*). Introduction to the Theory of Games	206
5.—*Tintner* (*G.*). Econometrics	206
6.—British Association for the Advancement of Science. Mathematical Tables, Vol. X. Bessel Functions, Pt. II	207
7.—Society of Actuaries. Report of Committee on New Recording Means and Computing Devices	208
8.—Forestry Commission. Census of Woodlands, 1947–1949	208
9.—*Staveley* (*R.*). (Ed.). Government Information and the Research Worker	209
10.—*Batchelor* (*J. H.*). Operations Research—A Preliminary Annotated Bibliography	209
11.—*Chapman* (*A. L.*). *and Knight* (*R.*). Wages and Salaries in the United Kingdom, 1920–1938	210
12.—Ministry of Food. Domestic Food Consumption and Expenditure, 1950	213
13.—*Lundberg* (*E.*). (Ed.). Income and Wealth, Series 1	214
14.—Ministry of Finance, Govt. of India. First Report of the National Income Committee, 1951	216
15.—*Blacker* (*C. P.*). (Ed.). Problem Families: Five Enquiries	217

1.—*Notes on the Teaching of Statistics in Schools.* By B. C. Brookes. London: Heinemann, 1952. viii + 80 pp. 7¼″. 5*s*.

When the Society's Committee on the Teaching of Statistics turned from consideration of teaching in Universities and University Colleges (for Report see *J. R. Stat. Soc.*, 1947, **110**, 51) to that in Schools (*ibid.*, 1952, A **115**, 126; both Reports obtainable from the Society's Offices), it was fortunate in securing the services of Mr. B. C. Brookes, who combined experience in teaching and examining in mathematics at school level with an interest in statistics. The "Notes" which have been published were first prepared in connection with discussions on the Committee, and they are now available to a wider public. Broadly speaking, there are two schools of thought on this question; one maintains that there is no place for statistical teaching in school, while the other is insistent that such teaching should enter as part of a broad general education. Opinions differ, too, as to how the subject should be taught at this level. The view has been held that it should have no place in a mathematical curriculum, but that the mathematics teacher might well devise courses for sixth-form students of biology. On the other hand, such syllabuses as have been prepared by some of the examining bodies for the General Certificate of Education, and the examination papers themselves, suggest that Statistics is an optional subject within the general subject Mathematics. At the present stage of development, with no general requirement that the subject be taught, but with a number of enthusiastic teachers experimenting with it, it is right that there should be a general measure of fluidity. At such a time examining bodies can play an important part by being gently encouraging; fortunately, most of these bodies tend to be so though not, unfortunately, all.

The "Notes", which are introduced by a Foreword written by Professor E. S. Pearson, who was Chairman of the Society's Teaching Committee, fall into two parts. Section I, occupying 49 pages, is an account of how the author approaches the subject at a very elementary level, and comprises a catalogue of suitable topics which should be included in the general curriculum. Section II, of 29 pages, is more of a teaching commentary on the various syllabuses in statistics of the examining bodies. The reviewer's opinion is that Section I is a most excellent short account of the elements of the subject; particularly intriguing are the suggestions of the ways in which material which must be strange to many school curricula could be used in association with the science teaching, and the children's experimental and out-door activities, for the benefit of those subjects and activities as well as adding to the child's mathematical knowledge and arithmetical facility. The material has been kept rigorously down to the basic essentials; occasionally reference is made forward to Section II but for the most part anything not considered essential, or understandable, is "washed out" completely.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A small number of critical comments may be made with a view to subsequent improvement of the Text of this Section. A decimal place has been left out of the bar-chart column of Table 1; on p. 7, in describing moving averages it is not strictly correct to describe m_2 as the average "of the next 10 readings" (it is the average of the 2nd to 11th); on p. 15 it would help in discussing the "average" to refer forward to p. 20 where the more general weighted average is dealt with; on p. 19 it would be better to replace 4 by 3 on the right-hand side of the inequality, especially as it will then be consistent with the next sentence; under correlation (pp. 30–36) it may prove confusing to many at this stage to have to deal with *two* regression lines in order to calculate the coefficient of correlation, especially since in so many practical problems there is only *one* regression line which has any meaning; Fig. 7 would be improved by a statement on it of which are Mathematics and which Physics marks; on p. 35 there is a misprint ($r = \sqrt{ab}$); in Fig. 9 (p. 47) the 20 on the vertical scale should be 25, and in the last sentence on p. 47 "100 successive samples of 5" is not consistent with the "whole universe" on the top line of the diagram.

In the reviewer's opinion, the author has been somewhat less successful with Section II. He begins by quoting two standard text-books and thereafter makes continual reference thereto. Broadly the work is authoritative and illuminating, but it suffers from being somewhat scrappy. It *may* help the teacher coming to the subject for the first time, but what would help him a great deal more would be an actual short text-book which would extract what was required from standard works such as Yule and Kendall, and Weatherburn, and leave everything else severely alone. The G.C.E. syllabus is, rightly, a brief and elementary one, and it discourages teachers to have to leaf over the hundreds of pages of Yule and Kendall to find what they want. This is no criticism of the author, who has, indeed, already collaborated in the production of an introductory text-book on the subject, but it leaves one asking for just a little more in the way of critical comment, neat proofs and the like, along the lines of what is given here.

A few comments on points of detail may perhaps be made on this section. Is it obvious (p. 58) that the coefficient of variation can be used only when the ratio s/m is small? Bernoulli is spelt wrong on p. 61; lower down the approximation to e should be $(1 + 1/n)^{n+\frac{1}{2}}$ and the numerical result is $2 \cdot 7557$ and the error of order $e/(12n^2)$. On p. 62 the use of (1) and (2) is surely a bit advanced; the reviewer has always found it easier to work out the first two *factorial* moments and then convert. A very easy derivation of the Poisson distribution consists in taking the limit of the *probability generating function* of the binomial; true, the idea of a generating function is not elementary, but in these simple cases it can be readily appreciated, and the proof is very neat, and probably an improvement on the author's p. 63. On p. 68, line 3 from bottom, the word "of" is better dropped; on p. 70 the last paragraph of 3(*h*) requires re-drafting to make it clear that information from samples is only pooled when there are a number, as in problem (ii) (c). It would be helpful to the reader to describe Table 8 a little more fully. In particular, what is the column headed "value"? On p. 75 it would be better to say "estimation" rather than "computation" of the covariance. Here it may puzzle the reader to introduce a $(n - 1)$ without explanation. Actually the *sum* of products of deviations from means is all that is required here. Under (iii) (p. 75) for "deviation" read "derivation". There is an α missing from the table on p. 77. In a way, it is a pity that the author has set out here to perpetuate the somewhat cumbrous notation of Yule and Kendall, which is overdue for suppression from that book. Lastly, the opportunity has been missed at the bottom of p. 77 to point out that only one "cell" need have its theoretical frequency calculated, since there is only one degree of freedom. JOHN WISHART.

2.—*Methods of Statistical Analysis.* By Cyril H. Goulden. 2nd Ed. New York: Wiley (London: Chapman & Hall), 1952. 467 pp. 9″. 60*s*.

Dr. Goulden in producing a second edition of his useful book (first published in 1939) has increased its length by 190 pages. Besides introducing many new topics, he has thoroughly recast and extended his presentation of the matter originally given. The resulting volume seems to the reviewer a handsome and valuable addition to statistical literature. This literature has in fact become so huge by the continuing spate of books that one hesitates before conceding the necessity for any particular newcomer. Dr. Goulden's book, however, seems certain amply to justify its existence. It is one of the few books in the field which the reviewer has read with ease and enjoyment. Statistics is of cardinal importance now in the world of science, and abounds in fascinating problems, but (with honourable exceptions) it thrives on the whole despite its writers, for few subjects more easily run to aridity of presentation or to monumental dullness.

Dr. Goulden however writes attractively in a clear, simple, and affable style, which draws the reader along with him. The reviewer opened the book intending to skip and scan, and stayed to read and digest. (Here the printer and publisher have given the author the support he deserved, the print and format are very pleasant and easy to the eye.) Dr. Goulden is a "tactful" writer;

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

a light and skilful touch is in evidence throughout. In particular the chapters introductory to statistical concepts, distributions and tests of significance are deftly managed—topics of which so many writers make heavy weather. (A purist might raise an eyebrow on being told to "solve a determinant" but this may be an established usage in North America.)

It is not possible to quarrel much with the choice of topics. There are no faddist inclusions and only one really notable omission. The book is directed to the research worker in practical fields of application, and to the student preparing for research. Primarily it is meant for people in Dr. Goulden's own field of experimental plant breeding where he has great experience and repute, being Chief of the Cereal Division of the Experimental Farm service in Canada. Consequently the core of the book consists of five chapters on aspects of experimental design, namely: Analysis of Variance, Basic Experimental Design, Factorial Experiments, Incomplete Block Experiments, Non-Orthogonal Data. These are supplemented by three excellent chapters on regression and correlation. The five chapters give a very lucid account of the principles and arguments required and a very considerable and up-to-date description of the many methods now in use for dealing with design and interpretation problems up to a very advanced level of complexity. The reviewer thinks Dr. Goulden's presentation is likely to hold its own for clarity among the many available. All the techniques described are, of course, important to many kinds of workers outside agriculture, and the author has achieved his aim of producing a text-book of general utility. There is a first-rate chapter on Discriminant Functions, now useful in many fields. The chapter on Probit Analysis is an excellent introduction to the subject. It is interesting to find a chapter on quality control in connection with seed sampling and inspection, together with an account of seed verification trials.

Special attention is given throughout to methods of setting out and performing statistical calculations both with reference to calculating machines and to the now obsolescent logarithm.

The notion of fiducial limits is used freely and correctly in the book. Curiously, while Dr. Goulden regularly introduces the notion of an estimate of a parameter, he never (even briefly) discusses the criteria of estimation. This seems to be the one serious lacuna in an otherwise first-class book suitable both for study and reference by workers in many fields.

A. R. G. Owen.

3.—*Modern Elementary Statistics.* By John E. Freund. New York: Prentice-Hall, Inc., 1952. x + 418 pp. 8¼″.

This is an American text-book of elementary statistics divided into four approximately equal parts, dealing respectively with descriptive statistics, probability and sampling, correlation, and special topics. The treatment, however, is not typically elementary because it includes "informally, topics that in the past have often been taught only on advanced level", and many theorems "are stated in the text without proof". This introduction to the more advanced statistical methods has advantages and disadvantages; the disadvantages obtrude whilst the advantages, certainly present, are more difficult to name. The book may be useful to those with a grounding in elementary methods and who need an introduction to some of the ideas of more advanced statistics. It is not, however, fully suitable for a beginner who is still learning mechanically.

An example may be quoted of the development when telling a student how to prepare a frequency distribution from raw data. To prevent his attempting to prepare a frequency distribution with 25 classes when he has only 5 measurements a formula is produced "based on mathematical considerations which are too advanced to be studied at this time". This seems to be a long jump, far too extreme for a text-book, but possibly excusable, for emphasis, in the classroom. We have, however, only a qualified exactness in the formula (as indicated by my italics) in the rule that it is "often *advisable* to get an *approximate* idea of the number of classes" (k) to be used in a frequency distribution by using the formula $k = 1 + 3{\cdot}3 \log_{10} N$, and that "it is, *of course*, not *necessary* that all classes be of equal length but it is *most certainly desirable*". It is not clear how much importance the student should attach to the rule, or how he should use his judgment in breaking it.

There are several minor annoyances in the text. Diagrams, for example, drawn to illustrate different kurtosis should not be drawn with different standard deviations. Nor is it usual to remove a trend and leave the deviations as fluctuating about a value below the smallest value of the series but markedly above zero. Nevertheless there is much to be commended in the book—the use of the sigma notation from the beginning, the early introduction of theoretical frequency distributions, and the development of the normal curve, probability and the testing of hypotheses. The treatment of correlation as associated with scientific prediction, however, whilst perhaps justified, may be dangerous. As with several modern texts, probability and significance tend to take the places of index numbers and the treatment of time series, which are relegated to the end

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of the volume and added almost as an afterthought. This seems to imply that the bias of the book is towards industrial, business and perhaps scientific applications of statistics rather than to the recording of economic and social developments of a community for which trend analysis and index numbers have good descriptive uses. H. S. BOOKER.

4.—*Introduction to the Theory of Games.* By J. C. C. McKinsey. New York: McGraw-Hill, 1952. x + 371 pp. 9″. 55*s*.

In 1944 John von Neumann and Oskar Morgenstern published their famous book on the "Theory of Games and Economic Behaviour." That great book will obviously become, if it is not already, a classic; not on account of its economic content but because of its development of the mathematical theory of games. Progress in the mathematics has been so rapid that eight years later we are presented with a new book on this mathematical theory which "is intended to be used as a college textbook for a course for upper division and graduate students." As a textbook it is very good; the arguments are well presented, examples are numerous and a particularly welcome feature is the emphasis on the unsolved problems. So often a textbook gives the subject the appearance of being completely tidied up, with no loose ends and no problems to solve, an appearance which kills interest. Since the theory of games is a young subject the loose ends and unsolved problems are many and the author is to be congratulated on stating them so clearly. It should serve to stimulate work on the subject.

The author begins with a discussion of zero-sum rectangular games in which each player chooses a number from a finite set and an umpire then suitably rewards the players according to a prescribed function of the choices, proves the fundamental theorem and then describes exact and approximate methods of finding the solutions. It is then shown how many games can be reduced to this simple form. The ideas are then extended to infinite sets and separable games and games with convex rewards are considered in more detail. The last part of the book is devoted to an interesting discussion of *n*-person games which is much clearer than von Neumann's exposition.

One of the delights of this theory is that comparatively simple tools are used. For quite a lot of the way the reader can get along on a little algebra and a few ideas on convergence and on maxima and minima; where additional material is needed the author gives a separate exposition, for example on distribution functions. But that is not to say that the use of these materials is simple; it is not. The fundamental theorem takes seven pages to prove after some introduction. Nevertheless anyone who is capable of enjoying a mathematical argument should enjoy the arguments here, though if it is enjoyment that the reader is after von Neumann is to be recommended. There is something exciting about that book, particularly the wonderful argument leading up to the concept of a strategy and the normalized form of a game. There is nothing anywhere near so exciting in McKinsey's book, but the argument is easier.

One chapter, of fourteen pages, is devoted to statistical inference. Only the very simplest ideas are discussed and none of the complex developments of Wald are given. The main result of the chapter must be to demonstrate the absurdity of the minimax theory when used without care. In Wald's theory the weights are always the losses that would be incurred if a wrong decision was taken in excess of those that would have been incurred had the right one been taken. McKinsey's matrices in the examples do not obey this requirement. D. V. LINDLEY.

5.—*Econometrics.* By Gerhard Tintner. New York: John Wiley (London: Chapman & Hall), 1952. xiii + 370 pp. 9″. $5.75.

Econometrics is divided into three parts. The first ("A non-technical introduction to Econometrics") covers 79 pages and deals with such topics as the scope, method and practical importance of econometrics. A series of illustrations of econometric research which is, in effect, a potted history of previous workers' achievements is also included. The 101 pages of Part II ("Introduction to multivariate analysis") deal with some of the main difficulties of applying multiple regression techniques to economic data. There is a considerable discussion of both the problems of errors in variables and their suggested solutions (e.g. weighted regression techniques) and the Cowles Commission *bête noir* of stochastic models with errors in equations. Part III ("Some topics in time series analysis") gives 140 pages to various methods of analysing trends and oscillatory movements and to the ramifications of autocorrelation together with some of the devices for side-stepping the difficulties inherent in this field. Finally, we have some 30 pages of Appendices dealing with the elements of matrices and determinants and with various aids and shortcuts to numerical computation.

The main point to be made about this book is that it does not cover the field of Econometrics as a whole but is at best an account, and in the reviewer's judgment, a one-sided account, of some

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

aspects of it. It will already be apparent from the relative size of the various parts that there is an overwhelming emphasis on time series problems. Now it is perfectly true that some of the most inhospitable parts of the unexplored territory of Econometrics are to be found here. But that may well be a reason for turning away from time series to cross-section data, or at least posing the question whether one ought to do so. There is in fact extremely little mention of cross-section data and none whatever of the path-breaking work of Tobin, published in this *Journal* in 1950. (There is, in fact, a footnote reference to Tobin's article which is a good illustration of a minor but constantly recurring irritation in the book. We have a reference to Stone's work on market demand functions on p. 40. The relevant footnote not only lists Stone's works but also Malmquist's book and Tobin's article without any further explanation. By this technique, repeated on virtually every page of the book, we are given an impressive demonstration of the author's erudition, but these references would be more useful in themselves and far less distracting to the reader of the text if they were collected together in a bibliography.)

But more important even than this unbalance in the structure of the book is the failure to face up to some of the really fundamental problems of econometric research. Given that there are different economic theories about some observed phenomena, how does one decide which theory to test? Supposing that the two equations, corresponding to two alternative theories, give equally good fits and equally reasonable estimates of elasticities (say), which does one select? Or, more fundamentally still, what does one mean by "equally reasonable"—how does one or can one choose between empirical estimates of (say) 0·8 and 0·9 for the marginal propensity to consume? And what are the consequences to be faced if no such choice is possible? Another "simple" problem—on what grounds does one choose a logarithmic as against a linear relationship? The almost complete omission of points such as this is, to say the least, highly regrettable. Finally, the amount of space devoted to "The Practical Importance of Econometrics" (3 pages out of 400) and the naïveté of many of the examples and their supposed relation to problems of economic policy are hardly calculated to inspire confidence or reliance on econometric techniques among general economists.

These drawbacks seem so important to the reviewer that it is impossible to recommend the book as giving a synoptic view of the place and potentialities of Econometrics even when full allowance is made for the difficulties of keeping pace with a rapidly growing subject. This, of course, does not mean that there is no gold in the hills at all. Chapter 7 gives a useful and succinct discussion of the Cowles Commission approach. Part III is a mine of information on statistical methods for dealing with time series and many of these are displayed with the skill and erudition of a practitioner, and a very up-to-date practitioner at that, as well as a theorist.

In sum, one cannot but admire Professor Tintner for his ingenuity; one cannot but despair at his ingenuousness.

A. R. PREST.

6.—*Mathematical Tables, Vol. X. Bessel Functions, Part II. Functions of Positive Integer Order*. London: C.U.P., for the British Association for the Advancement of Science. 1952. xl + 255 pp. 11″. 60*s*.

The policy of the well known British Association Tables has been, in the main, to provide to a high tabular accuracy certain important selected functions rather than tables of numerous functions to low working accuracy. The present volume (Vol. X) is true to this principle. It is the last of the series since in 1948 the responsibility for the calculation and publication of mathematical tables was transferred from the British Association to the Royal Society.

The volume is the second book of tables giving the Bessel functions J, Y, I and K. Its companion volume (Vol. VI of the series published in 1937) gave the functions of order zero or unity viz. $J_0 J_1$; $Y_0 Y_1$; $I_0 I_1$; $K_0 K_1$ whilst the present volume continues the tabulations to order 20. It was prepared on behalf of the Committee by W. G. Bickley, L. J. Comrie, D. H. Sadler, J. C. P. Miller and A. J. Thompson and its high standard of layout and typography is in line with the preceding volumes of this well known series of tables.

The book of tables is arranged in two parts, viz., Tables I to IV and V to VIII. In the first part the functions $J_n(x)$, $Y_n(x)$ or $y_n(x)$; $i_n(x)\ e^{-x}\ I_n(x)$ and $k_n(x)$ or $e^x\ K_n(x)$ to 8 decimals (or significant figures) for such intervals in x which make second order interpolation by Everett's formula (with modified second differences where necessary) normally yield tabular accuracy. In certain sections of the table a fourth order correction is required for which auxiliary tables are provided in the Introduction.

In the second part (Tables V to VIII) the function J_n, Y_n, I_n and K_n are given to 10 significant figures at wider intervals.

An admirable Tabular Page Index is provided to guide the user to the page where he can find each function to the required accuracy.

H. O. HARTLEY.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

7.—*Society of Actuaries: Report of Committee on New Recording Means and Computing Devices, September*, 1952. New York, 1952. vii + 107 pp. 10″.

This book contains a report on a "Special Meeting" arranged by the American Society of Actuaries at New York on September 25th, 1952, and dealing with the titular subject. It places on record the addresses by the President, B. T. Holmes, and the members of the Committee, M. E. Davis, J. J. Finelli and W. Klem (Part I), and supplements these with additional and more technical material bearing on the application of electronic computing devices to numerical operations occurring in the work of life insurance companies (Part II). The operations to be performed are fully detailed in the form of programme schedules, but the description of the machines used (or to be used) is confined to a summary of their respective functions without giving engineering details of their construction. It is a characteristic feature of commercial (or semi-commercial) calculations that the assembly and input of the data into the machines on the one hand and the recording of the resulting data and their refiling on the other hand form the major part of the operational activity, whilst the internal computing time is a relatively minor proportion. Only this latter activity is speeded up with the help of electronic devices, if the original data are recorded on punched cards and the result-data type-written.

The use of electronic devices for the internal computing stage only is, therefore, often of doubtful economy. An interesting possibility of dealing with this difficulty is the use of the magnetic tape as an intermediate input and output stage : The output of the electronic computor on to the magnetic tape is fast, and the transcription from tape to typed record may be speeded up by the use of a large number of tape-operated typewriters (see Mr. Finelli's address, p. 45), and similar arrangements can, no doubt, be made at the input stage. This possibility is, however, as yet only contemplated, and in any case would require a meticulous time-table in organising the operations of a company.

The book is of considerable interest in that it clearly illustrates the possibilities and difficulties of using electronic devices in commercial calculations. H. O. HARTLEY.

8.—*Census of Woodlands*, 1947–1949: Woodlands of five acres and over—Forestry Commission—Census Report No. 1. H.M.S.O., 1952. 264 pp. 12*s.* 6*d.*

This comprehensive census of the woodlands of England and Wales and Scotland relates to some 3½ million acres, or 6 per cent. of the land surface. It reviews in detail the findings of the *Census Summary Report* published in 1951. Data for the detailed planning and execution of forest policy have hitherto been inadequate. The present census provides a classification by area, based on the six-inch Ordnance Survey maps, of all woods of five acres and over according to type of crop, age-class, condition and species, and assesses the proportion of this area considered suitable for economic management. Global figures for the volume of standing timber classified by principal species and main categories of size have been obtained by a sampling process. Earlier surveys had been thrown completely out of date by the widespread fellings between 1939 and 1945. All the privately owned and State owned woodlands of five acres and over were visited by some 40 Census field staff and the information was classified into nine types, the most important by area and economically being the coniferous and the broad-leaved High Forests. About 80 per cent. of the total work was accounted for by the Area Survey, 15 per cent. by Volume Sampling and 5 per cent. by Increment Investigation. The average rate at which the Census field staff made the survey was 58 acres per head per day, and the cost per acre for the collection of the data was in the region of sixpence.

Among the main conclusions of the Census are:

(1) The total area of woodland in Great Britain at September 30th, 1947, excluding woods of less than 5 acres, was 3,448,000 acres or 0·07 acres per head of population, which is among the lowest in Western Europe. Of this acreage 2,825,000 acres or 82 per cent. are in private ownership, and 623,000 acres or 18 per cent. are under the direct administration of the Forestry Commission.

(2) Of the privately owned woods 13 per cent. (365,600 acres) and of the State woods 3 per cent. were classified as unsuitable for economic management. No less than 1,309,000 acres of woodland are either occupied by scrub or have been clear felled or devastated and are therefore unproductive.

(3) Woods productive or potentially productive at the date of the Survey account for 2,139,000 acres, of which 1,594,000 acres are in private ownership. High forest (1,789,000 acres) is 53 per cent. coniferous and 47 per cent. broad leaved. The bulk of both private and State planting over the past 30 years has been done with coniferous trees.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The *Census Report* provides essential information on the present timber resources of Great Britain, made necessary because of the changes which took place during the war. It contains as appendices statistical tables and maps illustrating the distribution of woodland areas by types and ownership and classified by productivity. J. H. GORVIN.

9.—*Government Information and the Research Worker: Lectures Delivered at a Vacation Course of the University of London School of Librarianship and Archives in April*, 1951. Edited by Ronald Staveley. The Library Association, 1952. vi + 228 pp. 8½″. 24*s*. (18*s*. to members).

Statisticians and research workers will find much useful and interesting information in this book and some which they should not miss.

Since the lectures were designed for and delivered to librarians it is not perhaps surprising that they appear to a statistician unsystematic. Listed and discussed together are such disparate items as historical and current papers, papers of general and even popular appeal, and others of interest only to a very small number of specialists.

The lecturers, mainly librarians, were drawn from each of the major departments (and some quite small divisions), with the exception of the Ministry of Civil Aviation and the Inland Revenue. They were asked to pay particular attention to the less familiar work of their departments, and they frequently refer to unpublished documents which "have achieved circulation". Perhaps even more useful than these dispersed references is the general indication of the policy and coverage of the material available, since this suggests where further inquiry might be rewarding.

Official documents are generally prepared by departmental specialists for the use of non-specialists and, perhaps for this reason, seldom give more than a selected sample of the data available in the department. To quote from the introduction to this book, "there is a growing volume of such information in all ministries that will never reach normal publication".

The research worker may be well-informed about published data, but cannot be expected to trace material in this quarry of unpublished documents, many of which (owing to printing difficulties and the need for stringent economy) are in duplicated form only. Thus material which might be of considerable interest to statisticians is often unknown outside the Government Service or even outside a single department. The work of the Technical Information and Documents Unit of the Department of Scientific and Industrial Research (formerly with the Board of Trade) and the work of the Information Department of the Treasury might have been unknown to many without this book.

How complete is the coverage of this book cannot be guessed. There are 24 contributions of varying length; that of the Ministry of Supply occupies less than two pages, while the chapters by the Ministry of Health, the Board of Trade and the (then) Ministry of Town and Country Planning and others are particularly detailed.

It would be invidious to select what is of most importance in all these unpublished data, but it may be noted that they contain material on Rating and Valuation and on the Poor Law Authorities. Research workers may like to have their attention directed to references to papers on methods. The chapter by the Librarian of the Government Social Survey (Miss G. M. K. Beck) reveals an unpublished document by Gray and Corlett, entitled, "The Register of Electors as a Sampling Frame". This is available on application to the Librarian. It also appears that this division has "some internal memoranda on methodological problems" which may be available to research workers.

This book does not aim at completeness, but rather at bringing to light unusual sources. Its only fault within its self-set limitations is its unsystematic presentation. The editor has, however, made a very bold attempt at indexing the volume, and although his index did not stand up to all the tests made upon it, a little imagination and a small amount of page-turning should quickly reveal what the book contains. L. T. WILKINS.

10.—*Operations Research—A Preliminary Annotated Bibliography*. By James H. Batchelor. Cleveland, Ohio: Case Institute of Technology, 1952. 95 pp. 8½″. $1.

This pamphlet gives references with brief abstracts of 309 books and articles with the intention of providing a guide to the existing literature on Operational Research which "might serve a useful convenience to those interested".

"Those interested" may be assumed to fall into either of two categories: those who have heard of operational research and want to learn what it is and what it does: and those who are working in the field and wish to keep abreast of the literature on the subject. For both these categories the assembly of references in one place is indeed a useful convenience. It may be doubted, however, whether either will find this assembly as satisfactory as it might have been. The author's

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

criterion for the inclusion of a reference in this bibliography has been that it "has been considered somewhere as pertinent to operational research". This uncritical approach has resulted in the inclusion of a number of references of doubtful applicability whose only effect is confusing; the newcomer, anxious to learn what operational research can do for him that is new, may be given the wrong impression when he sees, for example, purely statistical references included, such as Neyman and Pearson's 1933 paper on the most efficient tests of statistical hypotheses. This is not the stuff of operational research although statistical techniques are often basic to it.

Newcomer and expert alike will need a guide to find their way about among so many references. They are arranged here in alphabetical order of authors and the two indexes, one of periodicals and one of institutions, are only of limited use. It would have been more helpful to have had a subject index and perhaps better still to have arranged the references in sections according to some broad classification of their contents, such as definition, methodology, war-time case histories, industrial examples, etc.

These are unfortunate blemishes in the presentation of the material, for the author has performed a laborious and useful service in bringing the references together and in preparing the abstracts.

R. T. EDDISON.

11.—*Wages and Salaries in the United Kingdom*, 1920–1938. By Agatha L. Chapman, assisted by Rose Knight. Cambridge University Press, 1953. xiv + 254 pp. 12″. 55*s*.

This large volume is the first to be published of a projected series of five entitled "Studies in the National Income and Expenditure of the United Kingdom", which has been undertaken by the National Institute of Economic and Social Research in London jointly with the Department of Applied Economics at Cambridge. The general scheme of classification and coverage of the series is governed by those adopted by the Central Statistical Office and in other post-war official statistics. It may be hoped that the definitions of salariat and wage-earners can be used for international comparisons, such as are becoming available in the publications of the International Association for Research in Income and Wealth.

The investigation is much more elaborate than that used, or at any rate published, in earlier studies of national wages or income. Each of some 70 industries is treated in detail over 19 years, with full explanation of the sources of information (184 books or documents are listed), and the methods of assessing incomplete information are described in detail. Miss Chapman and her associates may be congratulated on the completion of a scholarly volume. It is only regrettable that its expense must limit its circulation.

The analysis is limited to earnings and salaries, "as payments, both in cash and kind, to employees for work performed". It does not cover the same field as "earned income" in the Income Tax sense, in which the income of persons employing their own capital is included. The difference between the two totals is substantial. We have for example in 1924:

Earned Income

	(*a*)	(*b*)
Wages	£1,600 mn.	£1,495 mn.
Salaries	742	746
Other	518	—
	2,860	

(*a*) is from Bowley and Stamp's *The National Income*, 1924, pp. 132–3, (*b*) is from Table 4 of the book here reviewed.

The tabulations are for industries as a whole, not for occupations, nor is there any study of distribution of earnings among individuals. Weekly wages are only used incidentally for comparison between years, or interpolation between years, and the emphasis is on total annual earnings, from which average annual earnings of employees can be deduced for each industry as a whole. Earnings of women are rarely shown separately from those of men.

Table 1 below shows the principal results (pp. 18 and 23). The exact measurement of the fall from 1920 to 1921 is somewhat conjectural, especially in timing, as is the effect of the general strike in 1926. The industrial groups with the most numerous employees are shown separately, since they bulk largely in the estimates of precision discussed below. Manufactures are all lumped together in Chapter II, but discussed separately in Chapter VI.

All students of the movement in time and of the totals of wages and of income are familiar with the numerous difficulties of definition, classification, sources of information, and generally of estimation. These are discussed in general terms in Chapters I and II, and methods adopted

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1

Total Numbers Employed and Total Annual Earnings United Kingdom* 1920–1938

Year	*All Industries*		*Manufactures*		*Miscellaneous services*		*Rest*	
	Number (mns.)	*Earnings (£mn.)*	*Number (mns.)*	*Earnings (£mn.)*	*Number (mns.)*	*Earnings (£mn.)*	*Number (mns.)*	*Earnings (£mn.)*
1920	17·7	3,406	6·7	1,207	2·0	317	9·0	1,882
1921	15·2	2,787	5·1	881	2·0	293	8·1	1,613
1922	15·3	2,352	5·4	754	1·9	228	8·0	1,370
1923	15·6	2,253	5·6	718	2·0	213	8·0	1,322
1924	15·9	2,309	5·7	739	2·0	221	8·2	1,349
1925	16·0	2,350	5·7	751	2·1	228	8·2	1,371
1926	15·6	2,262	5·6	728	2·1	232	8·1	1,302
1927	16·6	2,423	6·0	784	2·2	236	8·4	1,403
1928	16·7	2,415	6·0	783	2·2	239	8·5	1,393
1929	17·0	2,461	6·0	798	2·3	244	8·7	1,419
1930	16·6	2,400	5·6	734	2·3	244	8·7	1,422
1931	16·1	2,299	5·2	670	2·4	241	8·5	1,388
1932	16·2	2,272	5·3	671	2·4	244	8·5	1,357
1933	16·6	2,316	5·5	701	2·4	247	8·7	1,368
1934	17·1	2,419	5·8	747	2·5	255	8·8	1,417
1935	17·5	2,505	6·0	777	2·6	263	8·9	1,465
1936	18·1	2,647	6·3	838	2·6	276	9·2	1,533
1937	18·9	2,802	6·6	908	2·7	285	9·6	1,609
1938	18·9	2,890	6·5	924	2·8	306	9·6	1,660

* Salaries and wages.

are explained in detail in each subsequent chapter. The main sources for a comparative study over a period are the Censuses of Production and of Population, the reports on Unemployment Insurance and on the National Health Insurance Scheme, together with records and index-numbers of wage changes. In this book a large number of subsidiary sources are used, some of which were not available to earlier writers. The various reports are not consistent with each other in classification, coverage of industries, grouping by ages and in many other ways. The result of collation of these reports leaves a considerable uncertainty of the number to be classed as occupied; this is discussed in *Studies in the National Income*, 1924–38, pp. 101 *et seq.** The Census of Production does not cover the whole field, especially as regards professional and personal services, and for these there is a large element of conjecture. Receipts from tips, perquisites, and value of provided board and lodging are unknown or undefinable. The line between wages and salaries is drawn differently by different authorities, but there is adequate material in "Changes in Salaries in Great Britain" (*J. R. Statist. Soc.*, 1940, pp. 524–533), by Miss J. G. Marley.

In dealing with annual earnings a major difficulty is found in estimating the number of weeks to be applied as multiplier to the earnings recorded in one week to obtain the annual total. Allowance must be made for holidays, unemployment and strikes, short time and overtime, and some other items which depend partly on the estimated number gainfully occupied. Miss Chapman takes 49·4 weeks as in the first White Paper on Sources of War Finance, 1941. In *Studies in National Income* (*loc. cit.*, pp. 69–72) reasons are given for taking 48 weeks to be applied to the estimates of numbers there used. Estimates reached in 1938 for total wage-earnings (those for salaries are not comparable) are by Miss Chapman (p. 22) £1,788 mn.; White Paper† £1,735 mn., *Studies* (p. 81) £1,691 mn. These are all within the range £1,740 ± 50 mn., or ± 3%.

In Table 2 a comparison is made of the estimated movement of average earnings through the period 1924–1938, each column being expressed with the year 1931 = 1,000 as base, the panel A from *Studies* (p. 58) and B from the book under review (pp. 18 and 22). Though the numbers are computed on different methods, and total earnings depend on the number of weeks' work assumed, the averages (related to the central year 1931) show almost identical changes, differing from each other by less than 1 per cent. in each year, except 1926, the year of the general strike, and 1938, when the rearmament programme was under way. This consistence is a striking illustration of the principles that weighted averages are more precise than totals, and comparisons in time than those for single years, if the definitions in each series are unchanged.

* National Institute of Economic and Social Research, reprinted with corrections, 1944.
† White Paper: An Analysis of the Sources of War Finance etc. Cmd. 6623.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Number of Wage Earners, Total and Average Annual Earnings expressed Proportionately to Base 1,000 *in* 1931

Year	A			B		
	*Numbers**	*Total Earnings*	*Average Earnings*	*Numbers*	*Total Earnings*	*Average Earnings*
1924	1,076	1,115	1,036	1,023	1,067	1,044
1925	1,075	1,134	1,054	1,028	1,082	1,052
1926	1,065	1,109	1,040	986	1,014	1,028
1927	1,123	1,161	1,042	1,056	1,106	1,047
1928	1,104	1,134	1,027	1,056	1,091	1,032
1929	1,118	1,138	1,017	1,073	1,096	1,022
1930	1,057	1,080	1,023	1,040	1,068	1,028
1931	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*	*1,000*
1932	999	980	981	1,000	986	986
1933	1,028	1,000	972	1,024	1,002	977
1934	1,064	1,060	996	1,060	1,051	991
1935	1,096	1,115	1,017	1,082	1,090	1,007
1936	1,139	1,183	1,039	1,124	1,160	1,037
1937	1,174	1,245	1,064	1,168	1,235	1,057
1938	1,155	1,261	1,090	1,162	1,279	1,101

* "Earning strength".

The final chapter is headed "Reliability of Estimates" and is of great importance. Following the method used by Kuznets and in the Irish White Paper† the estimates of numbers and earnings are classified in "reliability" categories, viz.,

	Margins of Error
A. Firm figures	0–5 per cent.
B. Good estimates	5–10
C. Rough estimates	10–25
D. Conjectures	25 or more

The percentage margins are obtained as follows: "If it was thought that there was a 95 per cent. chance of the error in the component being less than 5 per cent., that component was placed in class A". If the 95 per cent. chance suggested a greater error, but less than 10, in class B, and so on. In this way the estimates of numbers of wage-earners and of salaried workers and of average earnings were classified for each of some 70 industries, and the classes of numbers and average earnings combined by formula for classification of the items of total earnings. Finally the classes for the separate industries were combined to estimate the class of the grand total. This procedure was followed for the two years 1920 and 1938.

Table 3 summarizes the principal results of the classification. The relative numbers and earnings are obtained from Chapter II, and the categories are as given on p. 234.

A further procedure is to assess "standard errors" for the class estimates, and these are taken as 1, 3 and 7 for classes A, B, C respectively; these numbers are not absolute, but only used as ratios.

First inspection of Table 3 suggests that the category assigned to the total should be B, not A, and detailed study for manufactures, here lumped together, also suggests B. If the letters are replaced in Table 3 by these numbers, and then weighted either by the relative numbers employed or by the relative earnings, we get (as shown under Table 3) an average 4·2, or if Manufactures are itemized, 4·8. This in examiners' notation would be termed β *minus*, not α.

The combination of the separate entries is not, however, by mean deviation, as above, but by the theory of error involving standard deviations. This involves correlations, whose sign even is not known, both between numbers of employees and earnings in each industry, and also between industries, so that apart from the difficulties involved in the use of the theory of chance, a further hazard is thus introduced. The result obtained (p. 236) as standard deviation for the total is 1·5 per cent. for 1938, and similarly 2·7 per cent. for 1920.

In the course of reaching this result it has been taken that the 95 : 5 chance named above for classification is equivalent to *twice* the standard deviation as in the normal curve of error, and

† Eire Government, National Income and Expenditure, 1946.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Reliability Classifications for Main Industrial Group, 1938

(*Wages and Salaries*)

*Industrial Group**	*Relative Number of Employees*	*Relative Earnings*	*Category of Reliability*
Agriculture	38	22	C
Fishing	2	3	C
Mining	42	46	A
Manufacturing	348	320	A†
Building	59	64	B
Public Utility	16	20	B
Transport	80	99	C
Distribution	130	112	C
Finance	24	48	C
National Government	35	52	A
Local Government	30	37	C
Professional	51	72	C
Other services	145	105	C
	1,000	1,000	A†

	Numbers	*Earnings*	*Assumed Class Value*
A	428	418	1
B	75	84	3
C	500	498	7
	1,000	1,000	Weighted average 4·2

* Titles abbreviated; Directors' fees omitted.
† See text.

therefore the chance assigned is that of being within the range of *once* the standard deviation, that is a chance of only 68 : 32, about 2 : 1 instead of 19 : 1. On this calculation the estimate for total employee earnings in 1938 may be written £2,944 mn. ± 44.

Considering the numerous assumptions involved in this estimate, it may be thought unfortunate that this should be given as the final estimate of the accuracy of the investigation. Cautious readers may prefer to use a B or 5 per cent. margin for comparison with estimates by other authorities.

A. L. BOWLEY.

12.—*Domestic Food Consumption and Expenditure*, 1950. Ministry of Food. London: H.M.S.O., 1952. 131 pp. 9½″ 4*s.* 6*d.*

Although sample surveys are now widely accepted as a useful instrument in government administration, there is a good deal of variation between Departments in the extent to which they make use of them. The Ministry of Food, more perhaps than any other, has shown how usefully such techniques can be geared to administration and policy-making. The National Food Survey was started in 1940 in order "to provide an independent check on the food consumption and expenditure of the population during the war, and thus to assess the effectiveness of the Government's war-time food policy". Because of its established value, and its relevance to rationing policy, the Survey was continued after the war.

When so much useful information had been collected during and after the war, it became a matter of criticism that the findings were not made public. The delay in publication came to an end in 1951 with the Ministry's report on "*The Urban Working-Class Diet* 1940 *to* 1949". The National Food Survey Committee, in presenting it, promised to publish a series of special studies, as well as Annual Reports dealing with the Survey findings from 1950 onwards. The volume under review is the first in this latter series.

In a sense it is much more interesting than its predecessor. The earlier report covered the years when the Survey was largely confined to the urban working-class. From 1950 onwards it has been based on a sample of the entire population, and this extension of the sample has made possible comparisons of the diet of different social classes (grouping is mainly on the basis of income of the head of household; four classes are distinguished). About a third of the report is taken up with these comparisons. Particularly useful among the other chapters are those on the diet of households of different family composition; on seasonal changes in food consumption;

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and on the energy value and nutrient content of the diet. An interesting appendix compares the 1950 diet with data obtained in pre-war surveys by Boyd Orr and Crawford and Broadley.

The survey methods are explained in another appendix. It seems clear that the new design —introduced with the extension of the sample in 1950—is an improvement. A two-stage sample is employed, the first-stage units being parliamentary constituencies. One cannot but express misgiving at the low response rate. Two series of addresses were randomly drawn, a "primary" and a "secondary" list. Up to three calls were made on "primary" addresses and, if no contact was then made, one call was made on a "secondary" address. If this too was unsuccessful, interviewers found a substitute address, following certain rules. The composition of the final sample is: "primary addresses" 49 per cent., "secondary addresses" 34 per cent. and substitutes 17 per cent. There is clearly a danger of bias here, and the report gives some evidence to suggest that households with no children under 16 and households in the highest social class are under-represented in the sample. It is thought, by the authors of the report, that the biasing effect is likely to be slight. Nevertheless, there is a weakness here and every effort should be made to overcome it. In view of the labour involved in completing the log books, the refusal rate may not be greatly reducible; the non-contact rate does however seem unduly high, and it may be necessary, though expensive, to do more call-backs.

However, it would be ungracious to end on a point of technical criticism. The Ministry is to be congratulated on issuing a report which, for completeness, quality of exposition and scientific objectivity attains a standard rare in official reports. The Survey has established itself as a most useful part of government administration. As a result of its findings we are well informed about the nation's present diet, changes in it over time, and its adequacy for different types of households and different social classes. As there seems to be some possibility of the Ministry of Food being abolished, or at least being materially reduced in scope, it may not be out of place to express the hope that this Survey will continue, if necessary under different auspices.

C. A. Moser.

13.—*Income and Wealth, Series I.* Edited by Erik Lundberg. International Association for Research in Income and Wealth. Cambridge: Bowes and Bowes, 1951. xv + 297 pp. 8½″. 30*s*.

The place of Quesnay's *Tableau Économique* in the ancestry of national income accounting is well known, but to most of us it may be news that the chemist Lavoisier demanded in 1791 an *établissement public* to draw up accounts in which agriculture (as well as other sectors) *serait considérée comme formant le domaine d'un seul individu*—what we should now call consolidated annual accounts—as a guide to economic policy. One of the authors of this symposium, Mr. Marczewski, quotes passages by Lavoisier which have a very modern ring:*

> "*On verrait alors quelle est l'influence de l'abondance des récoltes sur la richesse nationale, ce que le territoire peut supporter d'impôt dans une bonne année, le soulagement qu'il est nécessaire d'accorder dans une mauvaise; on connaîtrait ce qu'on peut exporter sans risques, etc. . . . Ces comptes généraux qu'on pourrait étendre à la population et à la balance du commerce formeraient un véritable thermomètre de la prospérité publique; et chaque législature verrait d'un coup d'oeil, dans les états sommaires, le bien comme le mal qui auraient résulté des opérations faites par les législatures précédentes.*"

The first essay in this collection, by Mr. Stone, deals with the functions and criteria of a system of *comptes généraux*, or, in modern terminology, social accounts. This paper is rather heavily formal, describing at length the roles of operating accounts, appropriation accounts and resting accounts; and it does not take the reader much further than the author's memorandum which was published as an Appendix to the League of Nations report on the same subject.† A paper discussing an accounting framework so generally might have considered not only the definitions of the types of account but also the definitions of the "transactors" (such as "households" or "enterprises"), for which separate accounts are devised. However, an authoritative statement of the uses of social accounting, and of the main problems of marrying theoretical requirements to statistical convenience, gives an appropriate start to the first volume published by this association.

* P. 112, derived from François Sellier, "Un précurseur sans disciples: Lavoisier", *Économie Appliquée*, Oct.,–Dec., 1948. pp. 665 *et seq.* In an even more striking anticipation of future developments, Lavoisier wrote: "*Un chapitre semblable serait ouvert pour toutes les productions du royaume. A ce compte général en nature serait joint un compte général en argent.*" (Contrast Leontief's *Structure of the American Economy, passim*).

† Studies and Reports on Statistical Methods, No. 7, 1947.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Four papers follow about the practical uses of "social accounting" in guiding the economic policies of the United States, France, the United Kingdom and the Netherlands. The French experience is the slenderest. The *établissement public* was set up (La Commission du Bilan National), but its work was hindered by two obstacles, "le manque presque total de statistiques sur le distribution des revenus", and "un vaste champ d'activité illégale qui échappait à toute investigation quantitative"—obstacles which were indeed, as Mr. Marczewski says, "majeurs". The Commission estimated the extra taxation needed to mop up inflationary pressures (*impôts* levied, alas, not because the year was good but because it was so bad), but the legislature seems to have given these results very cursory notice, for it reduced the taxes substantially, and the ill which has resulted from these operations still lies near the heart of Europe.

In the United States more attention has been paid to the accounts, at least by the Executive. Mr. Colm gives a brief historical description of the growth of the national accounts approach to fiscal problems: New Deal, the war, the fiasco of the reconversion forecasts, and finally the Economic Reports required under the Employment Act (1946). One interesting sidelight is that these reports have been partly based on physical analyses of the "bill of goods", or *compte nature*, implied by the forecasts of various types of expenditure. The author stresses that, in an economy which gives a limited role to government action, many of the economic forecasts are "orientative", or designed to influence behaviour of private groups, such as business men or farmers, whose actions have a wide effect on the economy. Indeed the recent Economic Reports seem much more designed to "orientate" the public than to guide Executive policy. Mr. Colm ends by almost asking whether the growing appreciation of national objectives will not modify the "disintegrating forces" of private capitalism.

Mr. Stuvel's paper is entitled "Recent Experiences in the Use of Social Accounting in the Netherlands", but it mostly consists of a rather elementary description of the principles of accounting and of the use of index numbers. While the general approach seems the same as elsewhere, there is little discussion of how the accounting approach guides policy-making, or of any practical results of applying this approach.

The paper on the United Kingdom is by Mr. E. F. Jackson, then responsible for the annual National Income White Papers. It is a paper which no student of British economic policy can ignore. This is the country where the prescriptions of Lavoisier have been most fully applied in practice: the shape of the post-war Budget and the scale of the investment programme have been mainly determined by the attempt to offset the inflationary tendencies revealed by projections (increasingly so, in fact, as "physical" controls have been dropped). This paper is the only place where the technique of projection is critically described. The Economic Surveys and the National Income White Papers are perhaps a little too indigestible to be absorbed by the legislature, especially in a *coup d'oeil*, but these documents (or perhaps the unpublished counterparts from which they are derived) have, as Mr. Jackson guardedly says, a decisive influence on the discussions "in government circles". The author frankly admits the weaknesses of this approach, and concludes that the margin of error in these calculations is much more than £100 millions, but he is surely right to claim that "bad evidence is better than no evidence" as a basis for decisions.

The remaining three essays are concerned with the other role of social accounting mentioned by Lavoisier—the provision of *un véritable thermomètre de la prospérité publique*. Professor Kuznets devotes a very long paper to the problem of deciding which government activities are contributions to the *prospérité publique*, i.e., the net national product. The net product is in fact defined by Professor Kuznets as an approximation to a measure of social welfare, and the corollary is that various activities undertaken in order to maintain the social framework (such as military expenditure) are excluded. It is important to stress that his treatment depends on his limitation of the purpose of economic activity, because those who prefer a wider view, or who feel that the attempt to measure "welfare" is in any case rather unfruitful, will hardly sustain sufficient interest to take them all the way through the rather tortuous paths, with many examples, by which he keeps the total of "factor shares" equal to the net product on his definition. The earlier sections of the paper are, however, interesting: such an intelligently and forcefully argued heresy is bound to stimulate reflection about the orthodox procedures in national accounting.

Dr. Derksen's paper discusses the techniques of "real" income comparisons in a number of countries, and briefly reviews the theoretical problems. The author finally comes down, rather surprisingly, in favour of deflated expenditure, rather than output series for various industries, as a means of measuring the changes in the "real" product. Are such attempts really so "very informative as to the exact meaning of the figures"?

Mr. Reddaway, the last author, holds the alternative view that "there are more and better quantity data for basic products than for final expenditure, so that the area in which we are dependent on uncertain price adjustments is considerably reduced". His paper discusses the main conceptual problems raised by the work done at Cambridge on the "real product" of the United

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Kingdom. Like all this author's work, it is masterly: at last—one feels—the important problems of "real" comparisons, including the difficulties involved in measuring the government's product, are reached; and this interesting volume is most competently brought to a close.

DUDLEY SEERS.

14.—*First Report of the National Income Committee, April*, 1951. Department of Economic Affairs: Ministry of Finance, Government of India. [Calcutta, 1951.] 2 pl., 102 pp. $9\frac{3}{4}''$. 2*s*.

The National Income Committee was appointed in 1949 by the Government of India "to prepare a report on the National Income and related estimates, to suggest measures for improving the quality of the available data and for the collection of further essential statistics, and to recommend ways and means of promoting research in the field of national income. The Committee will also guide the National Income Unit of the Government of India to compile authoritative estimates of the national income." The Committee consisted of Professor Mahalanobis (Chairman), Professor Gadgil (who was away during the final stages of drafting, and is not a signatory) Professor Rao and Dr. Desai (Secretary), and it has had the assistance of Dr. Derksen, Professor Kuznets and Mr. Stone as foreign advisers.

This interim report does not deal with all the terms of reference, but it does contain the most authoritative estimate available of the Indian national income, covering the year 1948–9. The explanation of this estimate takes up most of the Report, and one must at once say that it is very comprehensive. In order to make anything more than the most superficial use of national income estimates, particularly for underdeveloped countries, one really needs to see the working-sheets; official estimators have usually, understandably enough, refrained from fully revealing their hand, but the Indian statisticians have done so, and this is greatly to their credit.

The documentation and handling of statistical problems are both of a very high order throughout—but those using the Report should be careful to refer to the duplicated "Errata", since there are scores of misprints. It is clear from the full and frank description of the statistical difficulties that many of the estimates have a very limited meaning. Agricultural output is valued mainly at the prices operating in the chief markets, although it is estimated on p. 36 that only 28 per cent. of the rice production, for example, reaches *any* cash market. The quantities of crop output are also based on slender information, such as the "eye estimates" of the village *patwari*: in fact, for over a quarter of the country's area, wholly arbitrary estimates are used. Industrial production, outside the trades covered by the Census of Manufactures, is estimated by applying rough guesses of output per worker to estimates of the labour force based on a sample of the 1941 Census of Population. The difficulties of estimating tertiary production are even more acute.

These difficulties, although unavoidable, suggest that perhaps it is a little early as yet to show estimates of net output per person engaged in various activities (pp. 31–2). Since it is not unusual for people to take part in several activities, occupational data from censuses of the population of underdeveloped areas are notoriously unreliable, and the Committee seems optimistic to believe that ignoring this difficulty is "probably justified by the fact that part-time work in different sectors is likely to cancel out". It is also uncertain how many members of the family are assisting each "principal earner", especially in agriculture. Moreover, these estimates of output per head are to some extent (e.g., for "small enterprises") the result of assumptions about productivity rather than calculations obtained by dividing the labour force into the value of output. The Committee qualifies the results heavily, but nevertheless too much may be read into them.

It may be asked whether, in view of the practical and conceptual difficulties, the total national income itself is worth estimating. On this point, however, it is wise not to be dogmatic. The economic problems of India are so enormous that their solution must be a matter of decades, if not centuries; the part to be played by economic statistics can hardly be even guessed at, and we therefore cannot be sure that any particular statistical policy is correct. But is there slightly too much emphasis, perhaps, on the total national income in this Report? The merits claimed for the national income in its early pages (that it assists the wider implications of particular policies to be seen) are really the merits of a comprehensive system of economic statistics; and the examples chosen to illustrate these merits (such as estimating yields of sales taxes) refer to consumption statistics rather than statistics of the whole product.

Adding up the totals of estimates, as statistical research proceeds, is certainly not a useless operation, but should not the result be called "the sum of these activities", rather than "the national income"? The words "national income" invite comparison with the estimates prepared in more highly developed countries, estimates which have a different coverage in activities, and a different order of reliability. The title "national income" has also acquired special associations from theoretical work on its valuation, and from practical applications to the problems of industrialized areas.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

To query the central place given to an estimate of the "national income" is not, however, in any way to cast doubt on the value of the Committee's work. This is only a question of the emphasis in presentation. The Report forms a wide survey of Indian economic statistics. Many scraps of existing information are brought together and much new information is shown of great intrinsic value, notably current accounts of the public authorities, estimates of the balance of international transactions, and a statement of how this balance is financed. One chapter shows the information available for a set of double-entry social accounts, and ingeniously uses letters to fill gaps in the tables, thus bringing out their significance. The Report closes by describing what is being done to fill the gaps and strengthen the weak estimates. One can infer that further improvements will probably be very hard going, involving considerable fieldwork, but this Report shows that the long task of drawing up national accounts for the sub-continent is well under way.

DUDLEY SEERS.

15.—*Problem Families: Five Inquiries.* Edited by C. P. Blacker. London: Eugenics Society, 1952. 123 pp. 8½″. 5*s*.

These studies are concerned with a particular section of the population which constitutes a social problem in welfare and administration out of all proportion to its numerical size. Whilst their study has been thus forced upon the community, there has been since the war an increased interest in problem families as an object of sociological analysis. As the introduction says "the dark side of the urban industrialism, interest in the social importance of genealogy, concern over mental defectives, pre-occupation with the provision for hereditary infirmities, problems of war evacuation from large towns, and, most recently, the stirrings of conscience about children, have each, at different times, focused attention on problem families." The present volume reviews and brings together statistics obtained from five studies of problem families conducted by five independent groups but with some degree of co-ordination through the Problem Families Committee of the Eugenics Society. The main value of the work lies in the attempt to define objectively just what is meant by a *problem family*. Unfortunately, in this respect the statistics add little to the very well written introduction, which reviews much of the work hitherto done and draws upon the general impressions of the field workers. These impressions of course are themselves partially derived from the statistical studies. Some difficulty was encountered in obtaining co-operation from the various authorities who were in contact with problem families and who constituted the main sources of ascertainment of the existence of these families. One wonders whether this was because the co-operation was sought by letters indicating sponsorship by the Eugenics Society. In view of the difficult nature of these studies and the sensitivity of the various organizations to any suggestion that they might be serving pressure groups it would appear that such studies ought to be conducted by Local Health Authorities directly or, better still, by University Departments of Social Studies and without association with any particular private organization. The studies themselves cover housing conditions, broken homes, income, occupation, intelligence of householders and housewives, defects or abnormalities in parents and the intelligence and movements (away from home) of children. Much of the information is deprived of its value by the absence of any attempt to produce "control" figures from local sources or from other general surveys from which they could have been derived. One would have thought that the surveys themselves would have provided for a control group. Some of the information too, particularly in relation to such matters as the unskilled and irregular employment of the heads of households and other such conditions, merely reflect the criteria used in the selection of the families for study. With regard to the assessment of intelligence, regional variations indicate a large subjective element in this measure. An important part of this review is the chapter which gives suggestions for future enquiries. The suggestion is made that future ascertainments should be conducted under a joint sponsorship. Much of the information given in the studies points, however, to there being less difficulty if one department, for example, the Health Department of the Local Authority, were solely responsible than if an attempt were made to bring in different agencies with some competitive background; and Dr. Blacker does admit that "the best person to sponsor future inquiries is the medical officer of health." The amount of information which is considered necessary to deal with this problem seems exaggerated and far too complicated. It is rather to be hoped that future studies will be stringently restricted to such information as is necessary for control and prevention. The keeping of a simple local register coupled with observation of the families by skilled health visitors should prove adequate.

B. BENJAMIN.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

(1) British Official Statistics

The interim index of retail prices published by the Ministry of Labour and National Service which stood at 138 (prices at June 17th 1947 = 100) at December, 1952, rose to 139 in February and 140 in March. The rise was mainly due to increases in the prices of vegetables and coal. Separate figures on the same basis for different groups of commodities are not available, but the following are the figures based on 15th January, 1952 = 100:

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Alcoholic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
Dec. 16th	109·3	103·6	95·3	104·5	97·2	102·7	107·0	101·1	100·0	104·5
Jan. 13th	109·2	103·7	94·9	104·5	97·6	102·7	107·1	101·0	100·0	104·4
Feb. 17th	109·6	104·3	95·3	104·4	97·4	102·4	107·1	101·0	100·3	104·7
Mar. 17th	110·7	104·4	95·6	107·2	97·4	102·5	107·4	101·0	100·3	105·4

The Ministry of Labour index of weekly wage rates which was 134 (June 30th, 1947 = 100) at the end of December, 1952, rose to 135 in February and March. The increases in wage rates in this period affected mainly builders, coal miners and workers in wholesale bespoke tailoring, shirt making, and cocoa, chocolate and sugar confectionery manufacture.

The six-monthly inquiry into average earnings showed that in October, 1952, the average weekly earnings in the industries covered by the Ministry of Labour returns were 178*s.* 6*d.* for men, 96*s.* 4*d.* for women, 74*s.* 11*d.* for youths and boys, and 60*s.* 9*d.* for girls. These figures represent increases over October, 1938, of 159, 196, 187, and 228 per cent. For all workers combined the average was 151*s.* 11*d.*, 185 per cent. more than in October, 1938. The index number for October, 1952, compared with April, 1947, was 147. This compares with a rate of wages index for the same industries of 132. The average weekly hours worked were 46·1, the same as in October, 1951, and slightly higher than in April, 1952. In manufacturing industries alone the average weekly earnings in October, 1952, were 184*s.* 9*d.* for men and 96*s.* 10*d.* for women.

The total working population and the numbers in civil employment in the four months ended February, 1953, were as follows:

(*Thousands*)

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Nov., 1952	15,894	7,479	23,373	14,805	7,319	22,124
Dec., ,,	15,873	7,419	23,292	14,767	7,252	22,019
Jan., 1953	15,874	7,411	23,285	14,770	7,247	22,017
Feb., ,,	15,870	7,406	23,276	14,771	7,244	22,015

The above figures for the earlier dates have been slightly revised since they were first published, owing to the estimates of employers and self-employed persons which have become available from the 1951 census of population.

The number of persons on the unemployment registers of the Employment Exchanges rose by over 50,000 in January, but fell by about the same figure by March. The total of 397,038 at March 16th represented 1·9 per cent. of the estimated total of employees in Great Britain. The percentages in the separate Regions ranged from 0·7 in the North Midlands to 3·4 in Scotland and Wales.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The following is a sex analysis of the figures:

Numbers of Unemployed Persons on the Registers of Employment Exchanges

Date	*Men and Boys*	*Women and Girls*	*Total*
Dec. 8th, 1952	248,706	150,755	399,461
Jan. 12th, 1953	287,184	165,306	452,490
Feb. 16th, ,,	272,647	156,173	428,820
Mar. 16th, ,,	251,134	145,904	397,038

Of the total of 397,038 at March 16th, 39,221 were temporarily stopped, 89,481 had been unemployed for not more than two weeks, 95,256 from two to eight weeks, and 173,080 for over eight weeks.

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employed, were 936,900 in December, 1,065,500 in January, 1,220,900 in February, and 1,043,500 in March. The numbers of employed persons absent owing to industrial injury were 59,300, 63,200, 64,500, and 63,300.

---

(2) Other Statistics

The second volume of the *City of Birmingham Annual Abstract of Statistics* (1950–51) fully maintains the promise of its predecessor. A wide selection of non-financial statistics is contained within 182 tables which cover, as before, a large number of subjects ranging from the City's population to its weather. Most of the chapter and section headings specifically describe the subjects concerned, e.g., births, ambulance services, care of children. It is rather curious therefore that Chapter 6 should be given the general heading "Judicial and Protective Services" and not just "Police and Fire Service", which are the headings of the two sections comprising this chapter. There are one or two diagrams, the effectiveness of which suggests that they could be rather more freely employed. Any such criticism, however, can only be of minor degree, and does not, to any material extent, temper one's appreciation of this Abstract. At the modest price of 10*s.* 0*d.* it represents very good value, and sets an excellent example which other large cities could follow with advantage.

On page 298 of this *Journal* for 1952 appeared a notice of the Bibliography of Basic Texts and Monographs on Statistical Methods, published in 1951 by the International Statistical Institute in pursuance of that part of its Statistical Education Programme which is concerned with preparing aids to teaching. This review of basic material in the English language has now been followed by a similar work covering the French language compiled by Professor G. Darmois and Monsieur E. Morice of Paris—*Bibliographie sur la Methode Statistique et ses Applications. Liste des Principaux Ouvrages en Langue Française* (Paris, I.S.I., 1952). About sixty works are listed, drawn mainly from the literature of the last twenty years. The general arrangement is the same as for the earlier bibliography except that there are no review extracts with which to appraise the various works listed. This cannot be anything but a matter for regret since, unless the subject-matter is very specialized, an annotated bibliography must generally be more useful.

The international character of statistical work is illustrated in this new bibliography by the inclusion of translations of Sir Ronald Fisher's *Statistical Methods* and Dr. Yates's book on *Sampling Methods*, together with Mr. Richard Stone's pamphlet on *National Income and Accounting* (1947) for the erstwhile League of Nations—written in French but published by the United Nations in Geneva with a price in U.S. currency. The appearance of this second bibliography lends hope to the view that the International Statistical Institute may be arranging for further studies of this kind.

The fourth issues of the United Nations *Statistical Yearbook* and *Demographic Yearbook* dated 1952 have recently appeared. The former shows few changes in scope from the previous issues. A few minor tables have been omitted, but new tables are introduced for the first time on the structure of mining and quarrying, based largely on censuses of production, for 27 countries; on the number of spindles installed (cotton and wool) and of looms (wool) in about 30 countries;

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

consumption of steel (36 countries); and of gross national expenditure by items (20 countries). The latter in addition to its usual features devotes a special chapter to the geographical distribution of population and urban trends, based largely on the recent 1950–51 population censuses. A special map is given showing the countries which held population censuses in the years 1942–1953. A feature of this work is the attempt to appraise the quality of the statistics of population and to characterize the vital statistics (births, deaths and marriages) of each country as, (1) complete or virtually complete, (2) with incomplete coverage and subject to irregularity in registration, and (3) no information available.

The Food and Agriculture Organization has recently issued a study on *European Timber Trends and Prospects* (315 *pp.*). This study was prompted by the existence after the war of an acute timber shortage, and gives an analysis of consumption, production and trade, in an attempt to measure if the shortage is likely to continue. It estimates that Europe's demand for industrial wood may reach 210 million cubic metres in 1960, whereas production is not expected to exceed, under present programmes, 155 million. (Europe excludes the U.S.S.R.) The study advocates, and outlines, a "dynamic forest policy" under which 45 million cubic metres could be added to European supplies. It gives data of exports of timber from the U.S.S.R.—in the pre-war years it exported about 18 million cubic metres per annum, but since the war it has been a net importer—and states that the possibility of increased trade with the U.S.S.R. is a vital element in all calculations of future prospects. It estimates that maximum imports from this country might raise Europe's total supplies of industrial wood by about 10 per cent.

The Population Division of United Nations has begun the issue of a series of manuals on methods of estimating population of which the first has now appeared, entitled *Methods of Estimating Total Population for Current Dates* (Manual I, 1952, 45 pp.). Concerned especially with those countries (still numerous) where the available data are rather limited or of doubtful reliability, it shows how current estimates can be made even from few basic statistics, and how improvements can be effected in the estimates now being made. Methods of extrapolation based on two censuses and methods based on three or more are fully explained. Numerical examples of all the methods described are given for illustrative purposes based either on hypothetical or actual data. For the latter, Dr. Kuczynski's works on the demography of British Colonies are largely drawn upon.

The account of the various methods is preceded by a chapter on the problem of assessing the quality of population estimates, and an appendix discusses the use of sampling methods in the improvement of population estimates. Methods of estimating past and future populations and their composition by sex, age and other characteristics are to form the subject of future manuals.

The Economic Commission for Europe has issued under the title *Economic Survey of Europe since the War: A Reappraisal of Problems and Prospects* (385 pp.) its sixth annual report (1952). In this issue the emphasis is not on the events of the past year, but on the experience of the post-war period. Separate chapters are devoted to the economic policies of eastern Europe, the U.S.S.R. and western Europe, and for the first two many of the data are not normally available in the usual sources. The trade and payments problems and those of industrial development are then discussed, concluding with a section on the problem of European integration.

It is impossible in a short note to summarize or appraise the wealth of facts, figures and conclusions of this report. A few salient features may be noticed. The report declares that after five years of expansion, the economy of western Europe has stagnated since 1951, in spite of a steady increase in armaments expenditure and a boom in the United States; the present problem is to find means of further economic progress without again relapsing into inflation. The eastern regions of Europe have pursued an industrial revolution irrespective of cost; agricultural plans have remained modest, and there has been little rise in living standards. The output of certain important industrial products in the U.S.S.R. has now become comparable with that of the six "Schuman plan" countries plus the United Kingdom (which have about the same population). For four decennia there has been a persistent trend towards what is called "international disintegration" in Europe's economy. Since 1913 the output of commodities in Europe (excluding U.S.S.R.) may have increased 70 per cent., but intra-European trade increased by only 2 per cent. "In the all-important case of promoting international mobility of labour and capital, next to nothing has been achieved".

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The main preoccupation of western European countries, concludes the report, should be to increase dollar earnings, to increase production of food and raw material, to displace United States exports of manufactures in their own countries and in their overseas areas, to use more effectively "the goods and capital supplied to overseas areas so as to receive larger returns in the form of essential imports or dollars and to decrease the direct dollar outlays of these countries".

Statistical Services of the U.S. Government (revised ed. 1952), published by the Office of Statistical Standards, Bureau of the Budget, Washington, contains a general description of the statistical system of the United States Federal Government, together with notes on the principal types of economic and social statistics produced by that system. The first part of the pamphlet deals with the system in terms of organization, co-ordination—under the Office of Statistical Standards in the Bureau of the Budget—and some general practices. These latter embrace the uses of sampling as well as the special equipment involved, such as punched cards and electronic computers. Mention is also made of the various technical aids which are available, for example, the standard codes of statistical practice and the work of the Statistical Engineering and Mathematical Computation Laboratories of the National Bureau of Standards.

The second part of the pamphlet deals with the principal kinds of economic and social statistics, and provides an enviable review of the nature and sources of this kind of statistical material, which is supplemented by two detailed appendices giving the statistical responsibilities of the different Federal Agencies and a bibliography of the principal periodical statistical publications.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CURRENT NOTES

The International Congress of Mathematicians 1954 will be held in Amsterdam from September 2nd to September 9th, 1954, under the auspices of the Mathematical Society of the Netherlands. The Congress will be open to mathematicians from all parts of the world. The Organising Committee has invited a number of outstanding mathematicians to give one-hour addresses. There will be seven sections: Algebra and Theory of Numbers; Analysis; Geometry and Topology; Probability and Statistics; Mathematical Physics and Applied Mathematics; Logic and Foundations; Philosophy, History and Education. In each section half-hour addresses will be given by experts in the subjects. In addition short lectures of 15 minutes each are invited from members of the Congress, who are asked to make application beforehand to the Organizing Committee. Application forms for membership of the Conference and other information are obtainable from the Organizing Committee at 2d Boerhavestraat 49, Amsterdam.

The Council offers the Frances Wood Memorial Prize of £40 for competition in 1954.

As the object of the Prize is to encourage young investigators, competitors must be under the age of 35 on October 1st, 1954. It is hoped that this offer of a Prize will appeal specially to the younger Fellows of the Society, but it is also open to those who are not Fellows and in particular to members of the Research, Industrial Applications and Study Sections of the Society and of their Local Groups.

The Prize is offered for the best investigation, on statistical lines, of any problem chosen by the competitor which bears directly or indirectly upon economic or social conditions. Further particulars of the competition may be obtained from the Secretary.

The following honours to Fellows of the Society were announced in the Coronation Honours List :

Viscount: The Rt. Hon. Lord Woolton, P.C., C.H., D.L., LL.D.
Knight: Mr. G. D. A. MacDougall, C.B.E., M.A.
C.B.: Mr. J. Stafford, M.A.
C.M.G.: Mr. C. T. Saunders.
C.B.E.: Mr. W. F. Gardner, F.I.A., Mr. R. L. Gwilt, F.F.A., F.I.A., Mr. F. W. Lawe, Mr. L. G. K. Starke, B.A., F.I.A.
O.B.E.: Mr. D. H. Peacock, Miss N. G. M. Watts, B.Sc.(Econ.).
M.B.E.: Mr. J. R. Nesbit, M.C.I.A.

We congratulate these Fellows on the distinctions conferred upon them.

Fellows will also wish to congratulate Mr. J. Durbin, lecturer in statistics at the London School of Economics, on his appointment to the University readership in statistics, tenable at the School.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

October 1952—The use of accountancy terms and concepts by economists: *R. C. Tress.* The frequency and importance of errors in invoices received: *R. H. Gregory.* Recent developments in internal auditing: *H. C. M. Cobb.* Notes on the calculation of business profits during the present inflationary period in France: *J. Hammond.* Flow charts and diagrams of office systems: *P. N. Wallis.*

Advancement of Science—

December 1952—The logic of experiment: *J. Bronowski.*

Annals of Eugenics—

November 1952—The blood groups of the northern Sudanese: *P. J. Brooks, K. E. Garner, E. W. Ikin, A. E. Mourant* and *A. Drysdale.* The fertility of the parents of abnormals: *R. S. Krooth.* Taste deficiency in Lappish and Finnish populations: *A. C. Allison* and *H. R. Nevanlinna.*

British Journal of Preventive and Social Medicine—

January 1953—Differential fertility between women of blood groups O and A: *R. L. Kirk, M. Kirk* and *N. S. Stenhouse.* Epilepsy in school children: *P. Henderson.* Birth weights of South African babies—IV: *E. J. Salber* and *E. S. Bradshaw.* Investigation of the need for physical treatment during prolonged absence from work: *C. R. Lowe* and *T. McKeown.*

Bulletins on Soviet Economic Development, Series 2—

December 1952—Finance: *R. W. Davies.* A note on the productivity of labour in industry: *G. R. Barker.* A note on compulsory labour in the U.S.S.R.: *A. Baykov.*

Economica—

February 1953—Consumption theorems in terms of over-compensation rather than indifference comparisons: *P. A. Samuelson.* The decline of pawnbroking: *A. L. Minkes.* The origins of cheap money, 1931–2: *E. Nevin.*

Economic Journal—

December 1952—The Government's monetary policy: *A. H. Ensor* and *others.* Full employment in retrospect: *D. T. Jack.* The reduction of fluctuations in the incomes of primary producers: *P. T. Bauer* and *F. W. Paish.* Monopoly investigation and the rate of return on capital employed: *A. Silberston* and *D. Solomons.* Expectations and equilibrium: *F. H. Hahn.* A note on tertiary production: *A. G. B. Fisher.* Historical costs or present values?: *L. T. Little.*

March 1953—Depreciation, replacement and growth: *E. D. Domar.* A contribution towards a theory of customs unions: *H. Makower* and *G. Morton.* Mechanisation, utilisation and size of plant: *W. Baldamus.* Interdependence of consumer preferences in the theory of income redistribution: *S. F. James* and *W. Beckerman.* The theory of federal finance: *R. N. Bhargava.* 1948–49 recession re-examined: *E. C. Bratt* and *J. P. Ondrechen.* The capital coefficient and the rate of depreciation: *R. A. D. Egerton.*

Faculty of Actuaries, Transactions—

Vol. XXI, Part 1—The mortality aspect of population projections: *L. W. G. Tutt.*

Incorporated Statistician—

December 1952—High speed computers: their logical design, programming and other problems: *J. R. Womersley.* Accounting and statistical relationships: *F. Sewell Bray.* Statistics and investment: *L. G. Whyte.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Lloyds Bank Review—

January 1953—The international economic problem: *L. Robbins.* The economics of an ageing population: *W. A. B. Hopkin.* Economic policy in the Netherlands: *G. M. Verrijn Stuart.*

Manchester School of Economic and Social Studies—

January 1953—"Straddling" between commodity futures markets: *J. S. McClay.* A regional example of the mercantilist theory of economic policy: *J. M. Low.*

Oxford Economic Papers—

October 1952—The closure of entry in the American automobile industry: *H. G. Vatter.* Productivity in Canada, the United Kingdom, and the United States: *A. Maddison.* The early London clothing trades: *P. K. Newman.* A new approach to the theory of the firm: *A. Gabor* and *I. F. Pearce.*

Oxford University Institute of Statistics, Bulletin—

January 1953—Sample surveys for the social accounts of the household sector: *J. E. G. Utting* and *D. Cole.* The 30 per cent. liquidity ratio: *R. Frost.*

February and March 1953—National survey of personal incomes and savings: *H. F. Lydall.* The summer recession in 1952: *D. Seers.*

Population Studies—

March 1953—Income-tax allowances and the family in Great Britain: *A. M. Cartter.* A demographic study of an immigrant community: the Indian population of British East Africa: *C. J. Martin.* Emigration from Poland in the nineteenth and twentieth centuries: *J. Zubrzycki.* The fertility of the Jews in Palestine. A review of research: *K. R. Gabriel.* A note on occupation statistics in British censuses: *J. Bellamy.*

Review of Economic Studies—

Vol. XX (2)—Non-linear estimates of the Engel curves: *S. J. Prais.* Entrepreneur's risk, lender's risk, and investment: *L. Wellisz.* Long period determinants of Britain's terms of trade, 1880–1913: *G. M. Meier.* On the interpretation of Professor Leontief's system: *L. R. Klein.* The economic welfare function and Dr. Little's criterion: *C. Kennedy.*

Royal Society of Edinburgh, Proceedings, Section A—

Vol. LXIII, Part IV—Studies in practical mathematics: VII. On the theory of methods of factorizing polynomials by iterated division: *A. C. Aitken.*

EIRE—

Statistical and Social Inquiry Society of Ireland, Journal—

Vol. XVIII (1951–52)—Symposium on national income and social accounts. Factors influencing air transport rates and fares: *G. Fitzgerald.* Company accounting: *F. Sewell Bray.* The Electricity Supply Board: *R. F. Browne.*

INDIA—

Calcutta Statistical Association Bulletin—

October 1952—Seasonal fluctuations in the working class cost of living index in Calcutta: *S. Banerjee.* Placements effected by employment exchanges in India: *P. R. Sengupta.* The problem of missing quotations: *J. K. Pande.* Some useful results in Jacobinians: *S. N. Roy.* A note on Nair's condition for partially balanced incomplete block designs with $k > r$: *R. C. Bose.* Use of the analysis of covariance in two-stage sampling: *I. M. Chakravarti.* A note on the resolvability of balanced incomplete block designs: *P. M. Roy.*

UNITED STATES—

American Economic Review—

December 1952—Biological analogies in the theory of the firm: *E. T. Penrose.* Depreciation allowances, replacement requirements and growth: *R. Eisner.* The shape of the average

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

cost curve: *W. J. Eiteman* and *G. E. Guthrie.* Pitfalls in mathematical model-building: *A. C. Harberger.*

March 1953—National income and product, 1929–1950: *L. R. Klein.*

American Statistical Association, Journal—

December 1952—Use of ranks in one-criterion variance analysis: *W. Kruskal* and *W. Allen Wallis.* Serial number analysis: *L. A. Goodman.* Confidence intervals for medians and other position measures: *R. S. Woodruff.* Problems in inter-spatial comparisons of worker efficiency: illustrations from Puerto Rico: *S. Rottenberg.* Evolving mechanisms for the production of international health statistics: *H. L. Dunn.* A generalization of sampling without replacement from a finite universe: *D. G. Horvitz* and *D. J. Thompson.*

March 1953—Statistics and the public interest: *A. J. Wickens.* Data for measuring the effectiveness of public income-maintenance programs: *J. Fisher.* An appraisal of the 1950 census income data: *H. P. Miller.* Delimitation of economic areas: statistical conceptions in the study of the spatial structure of an economic system: *R. Vining.* Labor productivity in the Soviet Union: *I. H. Siegel.* On probabilities in Bridge: *D. F. Waugh* and *F. V. Waugh.* Probabilities of certain solitaire card games: *R. E. Greenwood.* Non-linear functional relationship between two variables when one variable is controlled: *R. C. Geary.* Combination of neighboring cells in contingency tables: *C. C. Craig.* Approximating the mode from weighted sample values: *H. L. Jones.* Estimating the ratio between the proportions of two classes when one is a sub-class of the other: *J. M. Elkin.* The circular normal distribution: theory and tables: *E. J. Gumbel, J. A. Greenwood* and *D. Durand.*

Annals of Mathematical Statistics—

December 1952—A measure of asymptotic efficiency for tests of a hypothesis based on the sum of observations: *H. Chernoff.* Orthogonal arrays of strength two and three: *R. C. Bose* and *K. A. Bush.* A non-parametric test for the several sample problem: *W. H. Kruskal.* Testing multiparameter hypotheses: *E. L. Lehmann.* Impartial decision rules and sufficient statistics: *R. R. Bahadur* and *L. A. Goodman.* Some distribution-free tests for the difference between two empirical cumulative distribution functions: *E. F. Drion.* Confidence bounds for a set of means: *D. A. S. Fraser.* Sequential minimax estimation for the rectangular distribution with unknown range: *J. Kiefer.* Extension of a method of investigating the properties of analysis of variance tests to the case of random and mixed models: *F. N. David* and *N. L. Johnson.* Some relations among the blocks of symmetrical group divisible designs: *W. S. Connor.* An optimum solution to the k-sample slippage problem for the normal distribution: *E. Paulson.* Limit theorems associated with variants of the von Mises statistics: *M. Rosenblatt.* A Markov chain derivation of discrete distributions: *F. G. Foster.* On minimum variance estimators: *J. Kiefer.* Bhattacharyya bounds without regularity assumptions: *D. A. S. Fraser* and *I. Guttman.* On the analysis of samples from k lists: *L. A. Goodman.* The standard error of Gini's mean difference: *Z. A. Lomnicki.* Correction to "A note on the power of a nonparametric test": *F. J. Massey, Jr.*

Bell System Technical Journal—

January 1953—Delay curves for calls served at random: *J. Riordan.*

Biometrics—

December 1952—The truncated Poisson: *F. N. David* and *N. L. Johnson.* Inverse, multiple and sequential sample censuses: *D. G. Chapman.* The estimation of response—time distributions II. Multi-stimulus distributions: *M. R. Sampford.* Statistical analysis of symmetrical slope-ratio assays of any number of test preparations: *P. M. Clarke.* Automatic machine method of calculating contingency χ^2: *J. Skory.*

Econometrica—

January 1953—The definition of econometrics: *G. Tintner.* Some recent uses of elasticity of substitution—a survey: *I. Morrissett.* Community preference fields: *W. M. Gorman.* Alternative conditions for social ordering: *C. Hildreth.* Emile Borel, initiator of the theory of psychological games and its application: *M. Fréchet.* The theory of play and integral equations with skew symmetric kernels; on games that involve chance and the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

skill of the players; and on systems of linear forms of skew symmetric determinant and the general theory of play: *E. Borel.* Two-person co-operative games: *J. Nash.* A comparison of treatments of a duo-poly situation: *J. P. Mayberry, J. F. Nash* and *M. Shubik.* Marginal productivity analysis—a defect and a remedy: *J. S. Henderson.* Guaranteed growth of income: *R. Eisner.* A note on the complete independence of the conditions for simple majority decision: *K. O. May.*

Estadistica—

December 1952—Utilización de los Datos Censales en el Cálculo de Ingreso y Producto Nacional y en el Análisis Económico: *M. Fadul.* Methodology and summary results of the 1950 birth registration test in the United States: *S. Shapiro* and *J. Schachter.* Muestras y Censos: *E. Cansado.* Document sensing in large-scale enumerative surveys: *R. D. Bothwell* and *D. B. Levine.* Indentificación Rural Previa como Sustituto de la Cartografía: IV Censo Agropecuario de la República Dominicana: *M. D. Herrera.* El Concepto de Actividad Productiva: *I. H. Siegel.*

Harvard Business Review—

January-February 1953—Formula plan investing: *R. A. Warren.*

Industrial Quality Control—

January 1953—An attribute chart for acceptance purposes: *F. Carlson.* The role of statistics in increasing the productivity of research: *C. A. Bicking.* Foundry quality control: *A. A. Evans.* Using statistics to improve contact quality: *J. L. Bemesderfer.*

March 1953—Problems of receiving inspection and the assembly line: *W. H. Smith.* The statistics in a gear-test program: *B. B. Day* and *F. R. Del Priore.* Control charts using midranges and medians: *E. B. Ferrell.*

Mathematical Tables and Other Aids to Computation—

January 1953—Addendum to a Guide to Tables on Punched Cards: *G. Blanch* and *E. C. Yowell.* The sieve problem for all-purpose computers: *D. H. L.* The use of large intervals in finite-difference equations: *L. Fox.* Monte Carlo matrix inversion and recurrent events: *H. P. Edmundson.*

Milbank Memorial Fund Quarterly—

January 1953—Characteristics of diabetics as revealed in a general morbidity study: *K. Simon.* The changing focus of differential fertility research: the social mobility hypothesis: *C. F. Westoff.* Relationship between family sizes of two successive generations: *J. Berent.*

Psychometrika—

September 1952—A two-sample test: *L. E. Moses.* Methods of solving some personnel-classification problems: *D. F. Votaw, Jr.* Some examples of multivariate analysis in educational and psychological research: *F. T. Tyler.* The rolling totals method of computing sums, sums of squares, and sums of cross-products: *J. D. Ayers* and *J. P. Stanley.* An extended table of chi-square for two degrees of freedom, for use in combining probabilities from independent samples: *M. H. Gordon, E. H. Loveland* and *E. E. Cureton.* Companion nomographs for testing the significance of the difference between uncorrelated percentages: *V. Appel.*

December 1952—Methodology in psychology: *J. C. Flanagan.* A statistical description of verbal learning: *G. A. Miller* and *W. J. McGill.* Note on the scaling of ratings or rankings when the numbers per subject are unequal: *E. E. Cureton.* Multidimensional scaling, I: Theory and method: *W. S. Torgerson.* The average Spearman rank correlation coefficient: *S. B. Lyerly.* The orthogonal approximation of an oblique structure in factor analysis: *B. F. Green.*

Review of Economics and Statistics—

February 1953—A real-financial system of social accounting: *A. L. Gaathon.* The earnings differential between white collar and manual occupations: *K. M. McCaffree.* The role of Japan in the intraregional trade of the Far East: *A. Y. C. Koo* and *C. C. Liang.* An interpretation of the Kuznets and Department of Commerce income concepts: *R. T.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Bowman and *R. A. Easterlin.* Electronic calculating methods for handling the excess capacity problem: *A. S. Manne* and *J. M. Frankovich.* The prices of investment goods and the volume of production in the United States: *H. Goris* and *L. M. Koyck.* Input-output matrices and index numbers: *G. R. Davies.* Income, savings balances, and net savings: *G. K. Brinegar.* Leads and lags in sterling payments: *S. I. Katz.*

AUSTRIA—

Statistische Vierteljahresschrift—

Vol. 5, Part 4—Zur Methodik des Konjunkturtest-Verfahrens: *J. Pfanzagl.* Zur Bayesschen Regel: *L. Schmetterer.*

BELGIUM—

Bulletin de l'Institut de Recherches Économiques et Sociales—

February 1953—Le rôle respectif de l'éducation et du revenu dans les dépenses alimentaires: *C. Roger.* Note sur l'élasticité de la demande de certains produits: *C. Baré.* Note sur le travail et les salaires en Belgique au XVIIIe siècle: *A. Verhaegen.*

EGYPT—

L'Egypte Contemporaine—

October 1952—Features of expansion and contraction in the Egyptian economy: *Y. El Molla.* The trade pattern of developing countries: *Z. Hashem.* Le problème de l'endettement rural en Egypte: *J. G. Economides.*

FRANCE—

Journal de la Société Statistique de Paris—

July-September 1952—Statistique et vaccination: *P. Vincent.* Une nouvelle méthode de classification et de recherche: *J. Pinel.*

GERMANY—

Mitteilungsblatt für Mathematische Statistik—

Vol. 5, Part 1—Klassenstatistik: *A. Adam.* Zur Anwendung der Varianzanalyse: *K. Brückner-Steinkuhl.* Zur Verrechnung und Zusammenfassung von Versuchsergebnissen mit der Varianzanalyse: *H. Geidel.* Spieltheorie und statistische Entscheidungsfragen: *S. Vajda.* Bemerkungen zur Theorie der Entscheidungsfunktionen: *E. Walter.* Vereinfachte Verrechnung eines "ausgewogenen Versuches in unvollständigen Blöcken", erläutert an einem Beispiel von A. Linder: *H. Geidel.*

Weltwirtschaftliches Archiv—

Vol. 69, Part 2—A note on the existence of a static equilibrium in the Leontief system: *T. M. Whitin.* Bemerkungen zum Verkehrsgesetz von Lardner: *M. J. Beckmann.* Der deutsche Aussenhandel im Rahmen der Welthandelsentwicklung: *F. von Bismarck-Osten.*

HOLLAND—

Statistica—

Vol. 6, No. 1—Papers on "Statistics and Productivity" presented at the Fifth Statistical Congress of the Netherlands Statistical Association, March 1952. (Dutch text, English summaries).

Vol. 6, No. 2—Enkele aspecten der mathematische statistiek: *J. Hemelrijk.* Existentiële gedachten over statistiek: *H. C. Kuiler.* De nationale rekeningen: *C. A. Oomens.* Statistiek in Amerika: *O. ten Have.* "De internationale statistische bijeenkomsten in India gehouden in December 1951": *H. C. Hamaker.* Een experiment met toevalsreeksen: *S. W. Visser* and *W. van der Bijl.* Methode van de kleinste kwadraten, toegepast op een stel simultane vergelijkingen die één of meer constanten gemeen hebben: *J. A. van der Heiden.* Elementair bewijs van de onafhankelijkheid van gemiddelde en spreiding bij steekproeven uit een normale verdeling: *J. van Ijzeren.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ITALY

Giornale degli Economisti Annali di Economia—

September-October 1952—Le teorie delle fluttuazioni economiche: M. Fanno. "Trend" e punti di inversione in una fluttuazione economica: *G. U. Papi*. Interventi sulla relazione Fanno: *G. del Vecchio*, *L. Amoroso*, *G. di Nardi*, *O. Fantini*, *M. de Luca* and *F. Chessa*. Le configurazioni ripetebili virtuali nell'analisi delle fluttuazioni economiche: *G. La Volpe*.

JAPAN—

Annals of the Institute of Statistical Mathematics—

Vol. IV, No. 1—Asymptotic properties of the estimates of an unknown parameter in stationary Markoff process: *A. Kazami*. A remark on the linear regression estimate: *M. D. Isida*. Note on the decision problem: *K. Matusita* and *H. Akaike*. Absolute moments in 3-dimensional normal distribution: *S. Nabeya*. Estimation of means on the basis of preliminary tests of significance: *B. M. Bennett*. On tests and estimates for the ratio of Poisson means: *D. G. Chapman*. Correction to the paper "On the theory of statistical decision functions": *K. Matusita*.

SWEDEN—

Skandinavisk Aktuarietidskrift—

Vol. 3, Part 4—Consistent estimators of the parameters of a linear structural relation: *J. Wolfowitz*. On the analysis of variance of percentage fractions: *P. Ottestad*. A short remark on the theory of random sampling and the theory of variance: *A. Jensen*. On the exhaustion process: *N. Blomqvist*. Certain nonlinear models of population and epidemic theory: *P. Whittle*. On principal components and least square methods of factor analysis: *P. Whittle*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part I, 1953, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

United Kingdom. *Board of Trade.* Census of distribution and other services 1950. Retail trade: short report . . . London, H.M.S.O., 1953. viii, 23p. 10¾″. 2*s.* 6*d.*

Colonial Office. An economic survey of the colonial territories 1951. Vol. VI. The Mediterranean and Pacific territories . . . 1953. 149p. 30*s.* Vol. VII. The products of the colonial territories. 1952. 249p. fold. diagrs. 42*s.* London, H.M.S.O. 13″. (Colonial, 281–6, 7.)

General Registrar Office. The Registrar General's decennial supplement England & Wales 1931. Part III. Estimates of population, statistics of marriages births and deaths, 1921–1930. London, H.M.S.O., 1952. vi, 574p. 13″. 70*s.*

H.M. Stationery Office. Consolidated index to Government publications 1936–1940. London, H.M.S.O., 1952. 178p. 9½″. 6*s.*

Ministry of Agriculture and Fisheries. Farm incomes in England & Wales 1950–1 (with some reference to earlier years): a report based on the Farm Management Survey. London, H.M.S.O., 1953. 71p. 12½″. 6*s.* 6*d.* (Farm Income Series, 4.).

Ministry of Civil Aviation. A survey of the accidents to aircraft of the United Kingdom in the year ended 31st December, 1951. London, H.M.S.O., 1953. 17p. 9¾″. 1*s.* 6*d.*

Ministry of Housing and Local Government. The cost of house-building: third report of the Committee of Inquiry. London, H.M.S.O., 1952. vi, 25p. 9¾″. 1*s.* 3*d.*

Ministry of Transport. Road accidents 1951. London, H.M.S.O., 1952. iv, 53p. 9½″. 3*s.* 6*d.*

Monopolies and Restrictive Practices Commission. Report on the supply of insulin . . . London, H.M.S.O., 1952. iii, 38p. 9¾″. 1*s.* 6*d.*

Scotland. Department of Agriculture. Scottish agricultural economics: some studies of current economic conditions in Scottish farming. Volume III. Edinburgh, H.M.S.O., 1952.

Scotland. General Registry Office. Census 1951: report on the fifteenth census of Scotland . . . Vol. I.—Part 3. City of Aberdeen. 36p. 8*s.* Part 4. City of Dundee. 46p. 8*s.* Part 5. County of Aberdeen. 48p. 11*s.* 6*d.* Edinburgh, H.M.S.O., 1953. 3 parts. 13″.

Social Survey. Labour mobility in Great Britain 1945–1949; by Geoffrey Thomas: an inquiry carried out for the Ministry of Labour and National Service. [1953.] 69, [11] p. 13″. (S.S. 134.)

Australia. *Commonwealth Bureau of Census and Statistics.* Census of the Commonwealth of Australia. 30th June, 1947. Part XVIII. Occupation. p. 1329–1521. Part XIX. Occupational status. p. 1526–1601. Part XX. Analysis of dwellings in local government areas. New South Wales. p. 1605–1689. Canberra [1952]. 3 parts. 13¼″. 2*s.* 6*d.* each part.

Brazil. *Conselho Nacional de Estatística. Serviço Nacional de Recenseamento.* Métodos dos censos de população das nações americanas. Rio de Janeiro, 1952. 5p.l., 94p. 12½″. (Documentos Censitarios. D, 1.)

O questito "religião" no censo demográfico de 1950. Rio de Janeiro, 1952. 30 l. 12¾″. (Documentos Censitarios, C, 1.)

Council of Europe. Economic relations with overseas countries; report by the Secretariat General. Strasbourg, 1952. 2p.l., 147p. 9¼″.

Quelques aspects de la démographie et de l'économie: étude statistique portant sur quelques aspects de la démographie et de l'économie des états membres du Conseil de l'Europe. Strasbourg, 1952. 62p. 9¼″.

Food and Agriculture Organization. Commodity reports: Fats and oils No. 4. Rome, 1952. 35p. 11″. 1*s.* 3*d.*

Commodity reports: Fibers No. 4. Carpet wool. Rome, 1952. 33p. 11″. 1*s.* 3*d.*

Commodity reports: Rice. Rome, 1952. 1p.l., 42p. 11″. 1*s.* 3*d.*

European timber trends and prospects: a study prepared jointly by the Secretariats of the Food and Agriculture Organization of the United Nations and the United Nations Economic Commission for Europe. Geneva, 1953 (London, H.M.S.O.). xvi, 315p. 11″. 25*s.*

F.A.O. Commodity series, Bulletin no. 22. Sugar. Rome, 1952. 131p. 11″. 2*s.* 6*d.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

F.A.O. Commodity series, Bulletin no. 23. Fruit and vegetables: production, trade and policies in Europe 1947–1951. Rome, 1952. 143p. 13″. 2*s.* 6*d.*

Grain exports by source and destination July 1951–June 1952. Rome, F.A.O., 1952. 24p. 11″.

Germany. *Statistisches Bundesamt.* Verzeichnis der Veröffentlichungen des Statistischen Bundesamtes. Stand: 1. Oktober 1952. 23p. 11¾″.

Methodische Einführung in die landwirtschaftliche Betriebszählung vom 22. Mai 1949. 1952. 71p. (Statistik der Bundesrepublik Deutschland 21. Heft 1).

Bodenbenutzung in den land- und forstwirtschaftlichen Betrieben. Heft 2. Ergebnisse der Landwirtschaftlichen Betriebszählung vom 22. Mai 1949. 1953. 564p. (S.B.D. 22.)

Viehhaltung in den land- und forstwirtschaftlichen Betrieben. Heft 2. Ergebnisse der Landwirtschaftlichen Betriebszählung vom 22. Mai 1949. 1952. 278p. (S.B.D. 24.)

Die berufliche und soziale Gliederung der Bevölkerung der Bundesrepublik Deutschland nach der Zählung vom 13.9.50. Teil I. Heft 2. Die Erwerbspersonen in der beruflichen Gliederung nach Alter und Familienstand, die Selbständigen Berufslosen nach Altersgruppen. 1953. 212p. (S.B.D. 36.)

Die berufliche und soziale Gliederung der Bevölkerung der Bundesrepublik Deutschland nach der Zählung vom 13.9.50. Teil II. Heft 2. Die Erwerbspersonen nach Wirtschaftszweigen und Stellung im Beruf. 1953. 87p. (S.B.D. 37.)

Die nichtlandwirtschaftlichen Arbeitsstätten in der Bundesrepublik Deutschland nach der Zählung vom 13.9.50. Heft 1. Die nichtlandwirtschaftlichen Arbeitsstätten (örtliche Einheiten) und die darin beschäftigten Personen. 1952. 126p. (S.B.D. 45.)

Die Schulden vom Bund, Ländern und Gemeinden am 31. März 1952. 1953. 35p. (S.B.D. 72.) Stuttgart-Köln, W. Kohlhammer. 11¾″.

Hyderabad. *Bureau of Economics and Statistics.* Hyderabad in maps. 1953. [v] 68p. 9¾″ × 14¾″. *Rs.* 1/8.

India. *Department of Economic Affairs.* First report of the National Income Committee April 1951. [Calcutta, 1951]. 2p.l., 102p. 9¾″. 2*s.*

Ministry of Home Affairs. Census of India 1951. Paper No. 6. Age tables—Uttar Pradesh 1941 on Y-sample. Paper No. 9. Age tables—Madhya Pradesh 1941 on Y-sample. Paper No. 10. Age tables—Bombay 1941 on Y-sample. Delhi. 3 papers. 11″.

International Monetary Fund. The world payments situation: a series of charts with commentary presented to the seventh annual meeting of the Board of Governors . . . at Mexico City September 8, 1952 . . . Washington, [1952]. 3p.l., 54p. 11″.

Japan. *Bureau of Statistics.* Population census of 1950. Vol. III. Results of ten percent sample tabulation. Pt. I. Sex, age, marital status, citizenship, education, household, housing, fertility. iv, 206p. Pt. 2. Labor force status, occupation, industry, class of worker, hours worked. vi, 450p. Tokyo, 1952. 2 vols. 10″.

Division of Health and Welfare Statistics. The social welfare statistics annual report 1951 no. 2. Tokyo, 1952. 160p. [10]p. diagrs. 10″.

New Zealand. *Census and Statistics Department.* Population census, 1951. Appendix A: census of poultry. Wellington, 1952. 19p. 12¼″.

Report on the income and income-tax statistics of New Zealand for the assessment years 1946–47, 1947–48, 1948–49, and 1949–50. Wellington, 1952. 112p. 13¼″. 12*s.* 6*d.*

Norway. *Statistik Sentralbyrå.* Nasjonalregnskap 1930–1939 og 1946–1951. Oslo, 1952. 335p. 9½″. (N.O.S. XI. 109.)

Organization for European Economic Co-operation. Chemical apparatus in the U.S.A.: report by a group of European experts. Paris, O.E.E.C., 1952. 224p. 9½″. (Technical Assistance Mission 23.)

Portugal. *Instituto Nacional de Estatística.* Análise de alguns indicadores demográficos. Lisboa, 1953. 50p. 10½″. (Estudos, 22.)

IX recenseamento geral da população no continente e ilhas adjacentes em 15 de Dezembro de 1950. Tome I. População residente e presente, famílias, casais, mulheres casadas, convivências, estrangeiros, cegos, surdos-mudos e órfãos. 798, [1] p. 80$. Tome II. Idade e instrução. 468p. diagrs. 60$. Lisboa, 1952. 2 vols. 10½″.

Southern Rhodesia. *Central African Statistical Office.* The national income and social accounts of Southern Rhodesia 1946–1951. Salisbury, 1952. 39p. 12¾″.

Report on Southern Rhodesia family expenditure survey, 1950–1951. Salisbury, 1952. iii, 74p. 12¾″.

Tenth report on the census of industrial production 1938–1950, covering (i) manufacturing (ii) construction (iii) water and light. Salisbury, 1952. 47p. 12¾″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Sweden. *Social Welfare Board.* Social Sweden. Stockholm, 1952. 462p. illus., map, fold. diagr. 9¾″.

Switzerland. *Eidgenössisches Statistisches Amt.* Anbaustatistik der Schweiz: Kulturen, Gewächshäuser und Treibbeetkästen der Erwerbsgärtnereien 1950. Bern, 1952. 104, 145p. 11¾″. (Statistische Quellenwerk der Schweiz 240.)

Eidgenössische Volkszählung 1. Dezember 1950. Bd.14. Kanton Schwyz. 1953. 116p. (S.Q.S.241.) Bd.18. Kantone unterwalden ob dem Wald und unterwalden nid dem Wald. 1952. 190p. (S.Q.S. 237.) Bd. 19. Kanton Uri. 1952. 102p. (S.Q.S. 239.) Bern, 3 vols. 11¾″.

Schweizerische Volkssterbetafeln . . . 1939/44: Ausscheide- und Überlebensordnungen nach dem Zivilstand . . . Bern, 1953. 55p. 11½″. (S.Q.S. 243.)

La Suisse en graphiques. Bern, 1952. 62p. 9½″.

Union of South Africa. *Bureau of Census and Statistics.* Seventh census of the population of the Union of South Africa, enumerated 7th May, 1946. Vol. II. Ages of the European, coloured, Asiatic and native population. Pretoria, 1950. v, 297p. 12¼″. 31*s.* 6*d.*

United Nations. *Department of Economic Affairs.* Economic survey of Europe since the war: a reappraisal of problems and prospects ; prepared by the Research and Planning Division, Economic Commission for Europe. Geneva, 1953. xii, 385p. 11″. 25*s.*

Governmental policies concerning unemployment, inflation and balance of payments 1951–52: analysis of replies by governments to a United Nations questionnaire. New York, 1952. viii, 135p. 9″. 7*s.* 6*d.*

A study of trade between Latin America and Europe; prepared by the Secretariats of the Economic Commission for Latin America, the Economic Commission for Europe and the Food and Agriculture Organization of the United Nations. Geneva, 1953. vii, 117p. 11″. 9*s.* (London, H.M.S.O.).

Department of Social Affairs. Population Division. Manuals on methods of estimating population. Manual I. Methods of estimating total population for current dates. New York, 1952. vi, 45p. 11″. 50*c.* (Population Studies, 10.)

United States of America. *Children's Bureau.* Infant and maternal mortality in metropolitan and outlying counties 1944–48. Washington, 1952. 62p. 10½″. (Statistical Series, 12.)

Adoption of children, 1951: a statistical analysis; by I. Richard Perlman and Jack Wiener. Washington, 1953. 17p. 10½″. (Statistical Series, 14.)

House of Representatives. Communication from the President of the United States transmitting the report of the President's Materials Policy Commission, June 1952, "Resources for freedom", vols. I to V, inclusive . . . Washington, Supt. of Documents, 1952. 5 vols. 11¾″.

National Bureau of Standards. A guide to tables of the normal probability integral. Washington, 1952. iv, 16p. 10″. 15*c.* (Applied Mathematics Series, 21.)

Introduction to the theory of stochastic processes depending on a continuous parameter; [by] Henry B. Mann. Washington, 1953. v, 45p. 10¼″. 30*c.* (Appl. Math. Ser. 24.)

Projects and publications of the National Applied Mathematics Laboratories. July/September, 1952—. In continuation. Washington, Supt. of Documents. 10¼″.

Tables of Bessel-Clifford functions of orders zero and one. Washington, 1953. ix, 72p. 10¼″. 45*c.* (Appl. Math. Ser. 28.)

Tables of Chebyshev polynomials $S_n(x)$ and $C_n(x)$. Washington, Supt. of Documents, 1952. xxix, 161p. 10¼″. $1.75. (Appl. Math. Ser. 9.)

Office of Statistical Standards. Statistical services of the United States Government. Rev. ed. Washington, Supt. of Documents, 1952. 78p. 10″.

Yugoslavia. *Savezni zavod za statistiku i evidenciju.* Popis stoke, živine i košnica 1949. (Census of livestock, poultry and beehives.) Beograd, 1952. 295p. 11½″. (Serija A III–Knjiga 1).

II.—AUTHORS AND MISCELLANEOUS

Anglo-American Council on Productivity. Productivity measurement in British industry: a symposium . . . London, New York, 1950. 38p. 9½″.

Anscombe (F. J.). Mr. Kneale on probability and induction. I. *Mind* (1951), **60**, 299–317. 8½″.

Barnard (G. A.). The frequency justification of certain sequential tests. *Biometrika* (1952), **39**, 144–150. 10¾″.

On the Fisher-Behrens test. *Biometrika* (1950), **37**, 203–207. 10¾″.

Significance tests for 2 × 2 tables. *Biometrika* (1947), **34**, 123–138. 10¾″.

A theory of mathematical statistics independent of the calculus of probability. XVIII. Congrès International de Philosophie des Sciences, Paris, 1949. IV. Calcul des Probabilités (1951), 115–124. 9½″. (Reprint from *Actualités Sci. Industr.* 1146.) Presented by the author.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Behrens (D. J.). The fitting of a distribution curve of known shape, but arbitrary origin and scale; an A.E.R.E. report . . . London, H.M.S.O., 1952. 1p.l., 8p. 12¾″. 1*s.* 9*d.* (A.E.R.E. T/M 50.)

Some notes on the nature of experiments, on the statistics of counting, and on the fitting of exponential decay curves to the results of counting experiments; an A.E.R.E. report . . . London, H.M.S.O., 1952. 42p. 12¾″. 6*s.* (A.E.R.E. T/R 629.)

Bellamy (Joyce) & Webb (Martyn). The foreign trade of Humberside: a study in post-war trade trends . . . Parts I and II. Written analysis. Part III. Statistical appendices. Hull, University College, Department of Economics and Commerce, 1952. 2 vols. 13″.

Berkson (Joseph) & Gage (Robert P.). Survival curve for cancer patients following treatment. *J. Amer. Statist. Ass.* (1952), **47**, 501–515. 9¼″. Presented by the authors.

Besterman (Theodore), *compiler.* Index bibliographicus: directory of current periodical abstracts and bibliographies. Vol. II. Social sciences, education, humanistic studies. 3rd ed. Paris, Unesco, 1952 (London, H.M.S.O.). xi, 72p. 10¾″. 9*s.* 6*d.*

Black (John Donald). Introduction to economics for agriculture. New York, Macmillan, 1953. xv, 727p. 9″. $6.

Braithwaite (Richard Bevan). Scientific explanation: a study of the function of theory, probability and law in science. C.U.P., 1953. xii, 375, [1]p. 10 diagrs. 8½″. 40*s.* [Based upon the Tarner Lectures, 1946.]

Brandwood (F.). Builders cost control bonusing and accounts. London, Gee, 1952. 147p. 2 fold. tables. 8½″. 25*s.*

Briggs (G. W.). Studies in management techniques. London, Gee, 1953. 203p. 8½″. 21*s.*

Burgdörfer (Friedrich). Bevölkerungsdynamik und Bevölkerungsbilanz: Entwicklung der Erdbevölkerung in Vergangenheit und Zukunft. München, J. F. Lehmanns, 1951. 116p. map. 9″. 14*s.* 6*d.*

Cadwell (J. H.). Distribution of the first quasi-range in samples from a normal population. Ordnance Board, 1953. 3 l. 13″. Presented by the author.

Cambridge, University of. Department of Applied Economics. Systems of aggregative index numbers and their compatibility; by Richard Stone and S. J. Prais. *Econ. J.* (1952), **62**, 565–583. 9¼″. (Reprint Series, 65.)

Safety first and the holding of assets; by A. D. Roy. *Econometrica* (1952), **20**, 431–449. 9¼″. (Reprint Series, 66.)

Les variations de qualité dans les budgets de famille; by H. S. Houthakker and S. J. Prais. *Econ. Appl.* (1952), **1**. 14p. 9¼″. (Reprint Series, 67.)

Carlucci (Giancarlo). Le svalutazioni monetarie inglesi del 1931 e del 1949. Milano, Università degli Studi di Milano, 1952. 26, [1]p. 9½″. 400 *l.* (Ist. Sci. Econ. Statist., Quaderni 15.)

Cattell (Raymond B.). Factor analysis: an introduction and manual for the psychologist and social scientist. New York, Harper, 1952. xiii, 462p. 8¼″. 48*s.*

Chand (Uttam). On the derivation and accuracy of certain formulas for sample sizes and operating characteristics of nonsequential sampling procedures. *J. Res. Nat. Bur. Stand.* (1951), **47**, 491–501. 10¼″.

Chapman (Agatha L.). Wages and salaries in the United Kingdom 1920–1938; by Agatha L. Chapman, assisted by Rose Knight. London, C.U.P., 1953. xiv, 254p. 12″. 55*s.* (Studies in the National Income and Expenditure of the United Kingdom, 5.)

Chinloy (T.), *& others.* An example of fractional replication in an experiment on sugar cane manuring; by T. Chinloy and R. F. Innes . . . and D. J. Finney . . . *J. Agric. Sci.* (1953), **43**. 11p. 10″. Presented by the authors.

The company prospectus: a series of four lectures delivered to the London and District Society of Chartered Accountants between November 13th, 1951, and March 11th, 1952 . . . London, Gee, 1953. 52p. 8½″. 3*s.* 6*d.*

Connolly (T. G.) & Sluckin (W.). An introduction to statistics for the social sciences. London, Cleaver-Hume, 1953. vii, 154p. fold.table. 8½″. 16*s.*

Cowles Commission for Research in Economics. Economic theory and measurement: a twenty year research report 1932–1952. Chicago, 1952. 4p.l., 180p. photos. 9″.

Curtis (C. R.). Statistics as applied to accounting data; adapted by C. R. Curtis . . . from *Advanced Accounting* . . . London, Sweet & Maxwell, 1953. 2p.l., 156 p. 9¾″. 22*s.* 6*d.*

Dandekar (V. M.). Report of an investigation into wastage and stagnation in primary education (Satara district). Poona, Gokhale Institute of Politics and Economics, 1952. 1p.l., ii, 86p. 9″. 4*s.* 6*d.*

David (F. N.). A statistical primer. London, Griffin, 1953. x, 226p. 8″. 22*s.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Dickinson (Frank G.) & Welker (Everett L.). Mortality trends in the United States 1900–1949 . . . and an editorial and summary from the Journal of the A.M.A. Chicago, American Medical Association, 1952. 32p. 11½″. (Bulletin 92.) Presented by the authors.

Doll (Richard) & Hill (A. Bradford). A study of the aetiology of carcinoma of the lung. *Brit. Med. J.* (1952), **2**, 1271–1286. 11″. Presented by the authors.

Dory (É.). Sur quelques problèmes provoqués par l'importance croissante prise par les mathématiques dans les programmes universitaires de sciences expérimentales. Louvain, Institut des Sciences Économiques Appliquées, [1952]. *Ann. Sci. Écon. Appl.* (1952), **no. 5**, 338–358. 9½″. Presented by Mr. F. A. A. Menzler.

Elliott (T. G.). A survey of production and industrial engineering organisation and practice in the U.S.A. and Canada. London, H.M.S.O., 1952. 32p. 7¾″. 1*s*. (D.S.I.R. Publications.)

Federation of British Industries. Guide to the excess profits levy . . . London, 1952. 31p. 8½″.

Fernandez (Alfredo) & Bonsignore (Jose Felix). Indice de precios. Montevideo, 1952. *Rev. Fac. Cienc. Econ. Adm.* (1951), **no. 2**. 31p. 11″.

Ferrari (Giovanni). Contributo allo studio del problema dell' alimentazione (bilancio alimentare di una regione italiana). *Statistica* (1952), **12**. 67p. 6 tables. 9½″.

Finney (D. J.). A note on "The estimation of the parameters of tolerance distributions". *Biometrika* (1952), **39**, 439. 11″.

Fisher (Sir Ronald A.) & Yates (Frank). Statistical tables for biological, agricultural and medical research . . . 4th ed. rev. and enlarged. Edinburgh, London, Oliver and Boyd, 1953. xi, 126p. 11″. 21*s*.

Fitch (A. A.) & Lloyd (E. H.). The precision of travel-time curves in the seismic method of geophysical surveying. *Proc. 3rd World Petrol. Congr.*, Section I, 1951, 497–513. 10½″.

Fürth (R.). On the theory of stochastic phenomena and its application to some problems of cosmic physics. Dublin, School of Cosmic Physics, 1952. 27, [1]p. diagrs. 11″. (Geophys. Bull. 5.)

Gerschenkron (Alexander). A dollar index of Soviet machinery output, 1927–8 to 1937; [by] Alexander Gerschenkron assisted by Alexander Erlich. Santa Monica, Calif., Rand Corporation, 1951. v, 357p. 9½″. (Report R-197.) Presented by the author.

Gore (W. L.). Statistical methods for chemical experimentation. New York & London, Interscience Publishers, 1952. xi, 210p. 7″. $3.50. (Interscience Manual, 1.)

Gorwala (A. D.). The role of the administrator: past, present, and future. [Poona], Gokhale Institute of Politics and Economics, 1952. 44p. 8½″. 2 *rs*.

Hammersley (J. M.). Tauberian theory for the asymptotic forms of statistical frequency functions. *Proc. Camb. Phil. Soc.* (1952), **48**, 592–599. 10″.

Hodges (J. L.) & Lehmann (E. L.). The use of previous experience in reaching statistical decisions. *Ann. Math. Statist.* (1952), **23**, 396–407. 10″. Presented by Dr. J. Neyman.

Inter American Statistical Institute. First session of the Committee on the 1950 census of the Americas of the Inter American Statistical Institute, Washington, D.C., September 2–8, and 16, 1947. Rio de Janeiro, Serviço Grafico do Instituto Brasileiro d Geografia e Estatistica, 1948. xvi, 184p. 9″.

International Association for Research in Income and Wealth. Bibliography on income and wealth. Volume II, 1948–1949; edited by Phyllis Deane. Cambridge, Bowes & Bowes, 1953. x, 11–109p. 10¾″. 37*s*. 6*d*.

International Economic Association. International economic papers no. 2. Translations prepared for the International Economic Association; ed. by A. T. Peacock, F. A. Lutz, R. Turvey, E. Henderson. London, Macmillan, 1952. 232p. 10″. 15*s*.

International Statistical Institute. Bibliographie sur la méthode statistique et ses applications: liste des principaux ouvrages en langue française. The Hague, 1952. 49p. 10½″.

Summaries of lectures delivered at the Statistical Seminar held at Calcutta, December, 1951. The Hague, 1952. v, 56p. 11½″.

Jones (C. W.). A short table for the Bessel functions $I_{n+\frac{1}{2}}(x)$, $\frac{2}{\pi} k_{n+\frac{1}{2}}(x)$; prepared on behalf of the Mathematical Tables Committee of the Royal Society . . . London, C.U.P., for The Royal Society, 1952. 20p. 11″. 6*s*. 6*d*.

Jones (N. S. Carey). The pattern of a dependent economy: the national income of British Honduras. C.U.P., 1953. xv, 162p. 8½″. 21*s*.

Keirstead (B. S.). An essay in the theory of profits and income distribution. Oxford, Blackwell, 1953. 4p.l., 110p. 8½″. 10*s*. 6*d*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Khintchine (A.). Asymptotische Gesetze der Wahrscheinlichkeitsrechnung. New York, Chelsea Publishing Co., 1948. iv, 77p. 8½″. 15*s*. (Ergebnisse der Mathematik und ihrer Grenzgebiete, Bd. 2, 4.)

Lehmann (E. L.). On the existence of least favorable distributions. *Ann. Math. Statist.* (1952), **23**, 408–416. 10″. Presented by Dr. J. Neyman.

Lloyd (E. H.). Least squares estimation of location and scale parameters using order statistics. *Biometrika* (1952), **39**, 88–95. 10¾″.

On the estimation of variance and covariance. *Proc. Roy. Soc. Edinb.* A (1952), **63**, 280–289. 10″.

London School of Economics and Political Science. Division of Research Techniques. Differences in results obtained by experienced and inexperienced interviewers; by H. S. Booker and S. T. David. *J. R. Statist. Soc.* A (1952), **115**, 232–257. 10″. (Reprint Series, 17.) Quota sampling; by C. A. Moser. *J. R. Statist. Soc.* A (1952), **115**, 411–423. 10″. (Reprint Series, 18.)

The power of two difference-sign tests; by A. Stuart. *J. Amer. Statist. Ass.* (1952), **47**, 416–424. 10″. (Reprint Series, 19.)

McIntyre (A. D.). Statistics of the Scottish halibut fishery 1930–1949. Edinburgh, H.M.S.O., 1952. 24p. 11″. 4*s*. (Marine Research 1952, 1.)

McKay (D. H.) & Martin (W. J.). Dentition and physique of Bantu children. *J. Trop. Med. (Hyg.)* (1952), **55**, 265–275.

Markjof (Manfred Mautner) & Nemschak (Frans). Zum 25jährigen Bestand des österreichischen Institutes für Wirtschaftsforschung. Wien, Österreichisches Institut für Wirtschaftsforschung, 1952. 20p. 9½″.

Marshall (W. A. L.). A century of London weather. London, H.M.S.O., 1952. 103p. 9½″. 15*s*. (M.O. 508.)

Miani-Calabrese (Donato). Tre orientamenti di studi dell'artigianato (giuridico, statistico, economico). *Riv. Lavoro* (1952), **2**. 19p. 9½″. Presented by the author.

Milano. Camera di Commercio Industria e Agricoltura di Milano. Aspetti della disoccupazione in provincia di Milano. [Milano], 1953. 2p.l., 133, [2]p. 9½″. 800 *l*.

Moran (P. A. P.). The statistical analysis of game-bird records. *J. Anim. Ecol.* (1952), **21**, 154–158. 10″.

Mounsey (J.). Introduction to statistical calculations. London, English Universities Press, 1952. xi, [12]–351p. 7¼″. 15*s*.

Murphy (Kathryn R.) & Gordon (Edward M.). Labor requirements for building Air Force housing. Reprinted (with additional data) from the *Mon. Labor Rev.* (1952), **75**. 7p. 10¼″.

Netherlands. Centraal Planbureau. De voorkeur voor het "eigen huis"; door Dr. J. G. M. Delfgaauw. *Economie* (1952), **17**, 204–227. 9¼″. (Overdrukken, 16.)

The influence of productivity on economic welfare; [by] Prof. Dr. J. Tinbergen. *Econ. J.* (1952), **62**, 68–86. 9¼″. (Reprint Series, 17.)

De financiele positie van de middingroepen in loondienst: een statistische vergelijking van 1951 met 1938. *Katholiek Staatkundig Maandschr.* (1952), **May**. 44p. 9¼″. (Overdrukken, 18.)

Industrialisatie-en emigratiepolitiek; door R. J. P. van Glinstra Bleeker. *Econ.-Stat. Ber.* (1952), **37**, 688–692. 12p. 9½″. (Overdrukken, 19.)

Betrekking tussen de hoogte van de prijsindices van het gezinsverbruik, het inkomen en de gezinsgrootte; door A. I. V. Massizzo. *Economie* (1952), **Juli/Aug.**, 522–538. 19p. 9¼″. (Overdrukken, 20.)

Enige gegevens betreffende de toekomstige behoefte aan medici; door Prof. Dr. P. J. Verdoorn en F. Th. van der Maden. 1952. 9¼″. (Overdrukken, 21.)

Welke zijn de achtergronden en vooruitzichten van de economische integratie in Europa en welke gevolgen zou deze integratie hebben, met name voor de welvaart in Nederland? door Prof. Dr. P. J. Verdoorn. 1952. 93p. 9½″. (Overdrukken, 22.)

Normatieve budgetten; door Ed. van Cleeff. *De Economist* (1953), **Febr.**, 119–143. 27p. 9½″. (Overdrukken, 23.) With English summary.

Neyman (J.) & Scott (E. L.). A theory of the spatial distributions of galaxies. *Astrophys. J.* (1952), **116**, 144–163. 9½″. Presented by the authors.

North Carolina, Consolidated University of. Institute of Statistics. Classification and analysis of partially balanced incomplete block designs with two associate classes; by R. C. Bose and T. Shimamoto. *J. Amer. Statist. Ass.* (1952), **47**, 151–184. 9″. (Reprint Series, 20.)

Research notes on a property of Bayes solutions in the Neyman-Pearson set-up; by S. N. Roy. *Calcutta Statist. Ass. Bull.* (1952), **4**, 67–71. 9″. (Reprint Series, 21.)

Analysis of partially balanced incomplete block designs illustrated on the simple square and rectangular lattices; by K. R. Nair. *Biometrics* (1952), **8**, 122–155. 9″. (Reprint Series, 22.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Algebraic relationships between digestion coefficients determined by the conventional method and by indicator methods; by H. L. Lucas. *Science* (1952), **116**, 301–302. 9¼″. (Reprint Series, 23.)

Use of continued fractions in high speed computing; by D. Teichroew. *Math. Tab. Wash.* (1952), **6**, 127–133. 9″. (Reprint Series, 24.)

Combinatorial properties of group divisible incomplete block designs; by R. C. Bose and W. S. Connor. *Ann. Math. Statist.* (1952), **23**, 367–383. 9″. (Reprint Series, 25.)

Some aspects of the sequential design of experiments; by Herbert Robbins. *Bull. Amer. Math. Soc.* (1952), **58**, 527–535. 8¾″. (Reprint Series, 26.)

Orthogonal arrays of strength two and three; by R. C. Bose and K. A. Bush. *Ann. Math. Statist.* (1952), **23**, 508–524. 9¾″.

Onody (Oliver). Pesquisas e estudos econômicos na Europa: Inglaterra, Alemanha, França, Espanha, Suíça. São Paulo, 1952. 136p. 9¼″. Presented by the author.

Pearce (S. C.). Field experimentation with fruit trees and other perennial plants. [Farnham Royal, Bucks] Commonwealth Agricultural Bureaux, 1953. x, 131p. 9¾″. 10*s*. (*Tech. Commun. Bur. Hort. E. Malling*, 23.) Presented by the author.

Pimental (Paulo). Teste de qualidade pela análise sequencial: classificão de lotes. Recife, Pernambuco, Departamento Estadual de Estatistica, 1951. v, [7]–28p. 9″.

Political and Economic Planning. The British fuel and power industries: a report by PEP. London, 1947. xi, 406p. 9¾″.

Putter (Joseph). Sur une méthode de double échantillonnage pour estimer la moyenne d'une population laplacienne stratifiée. *Rev. Inst. Int. Statist.* (1951) **19**. 8p. 10¼″. Presented by Prof. J. Neyman.

Quenouille (M. H.). The design and analysis of experiment. London, Griffin, 1953. xiii, 356 p. 8¾″. 36*s*.

Reading, University of. Department of Agricultural Economics. The horticultural industry of Middlesex; by L. G. Bennett . . . Reading, 1952. 70p. 9½″. 10*s*. (Misc. Stud. 7.)

Redmayne (Paul) & Weeks (Hugh). Market Research. 2nd ed. Rev. and rewritten by R. N. Wadsworth . . . and B. D. Copland . . . London, Butterworth, 1951. xi, 196p. 8½″. 17*s*. 6*d*.

Rushton (S.). On a sequential *t*-test. *Biometrika* (1950), **37**, 326–333. 10¾″.

On a two-sided sequential *t*-test. *Biometrika* (1952), **39**, 302–308. 10¾″. Presented by the author.

Rushton (S.) & Davies (D. R. G.). The variation in electrical properties of silicon-iron transformer sheet: a statistical analysis of data from a single cast. *J. Iron St. Inst.* (1951), **167**, 247–261. 11″.

Schlote (Werner). British overseas trade from 1700 to the 1930s; by Werner Schlote . . . Tr. by W. O. Henderson . . . and W. H. Chaloner . . . Oxford, Blackwell, 1952. xvi, 181p. 8¾″. 22*s*. 6*d*.

Society of Actuaries. Report of Committee on New Recording Means and Computing Devices September, 1952. New York, 1952. vii, 107p. 10″. Presented by Mr. M. E. Davis.

Spear (Mary Eleanor). Charting statistics. New York, London, [etc.] McGraw-Hill, 1952. xii, 253p. 9″. 38*s*. 6*d*.

Stevenson (A. C.) & Cheesman (E. A.). Heredity and rheumatic fever; a study of 462 families ascertained by an affected child and 51 families ascertained by an affected mother. *Ann. Eugen. Lond.* (1953) **17**, 177–210.

Swerling (Boris C.). Commodity measures for international economic stability. *Can. J. Econ. Political Sci.* (1952), **18**, 378–383. 10″.

Tinbergen (Jan). Les fondements mathématiques de la stabilisation du mouvement des affaires. Paris, Hermann, 1938. 114p. 10″. (Actualités Sci. Industr. 632.)

Tocher (K. D.). Extension of the Neyman-Pearson theory of tests to discontinuous variates. *Biometrika* (1950) **37**, 130–144. 10¾″.

The Imperial College of Science . . . Mathematics Department. Report on the work of the computor group. Part I; by K. D. Tocher . . . London, Imperial College of Science, 1952. 4p.l., 125p. 13″. Presented by Prof. Levy.

A note on the analysis of grouped data. *Biometrika* (1949), **36**, 9–17. 10¾″.

A note on the design problem. *Biometrika* (1952), **39**, 1p. 10¾″.

On the concurrence of a set of regression lines. *Biometrika* (1952), **39**, 109–117. 10¾″. Presented by the author.

Tokyo Spinning Co. Institute for Economic Research. Causes of decline in the world's cotton textile trade. Osaka, 1952. 2p.l., 48p. 10″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Trumpler (Robert J.) & Weaver (Harold F.). Statistical astronomy. Berkeley, Univ. California, 1953 (London, Camb. Univ. Press). 11p.l., 644p. 9¾″. $7.50.

Vinci (Felice). Interventi sul nuovo assetto Europeo, sull' accertamento della miseria, sulle richerche econometriche e sull' illusione finanziaria. Milan, 1952. 22, [1] p. 9½″. 400 *l.* (Univ. degli Studi di Milano, Ist. Sci. Econ. Statist., Quaderni 16.)

La teoria dell' illusione finanziaria di A. Puviani nel sua cinquantesimo anniversario coll' appendice di uno scritto precursore . . . Milan, 1953. 33p. 9¾″. (Nuove analise economiche e finanziarie.)

Waugh (Albert E.). Statistical tables and problems . . . 3rd ed. New York, London, [etc.] McGraw-Hill, 1952. xiv, 242p. 9″. 25*s.* 6*d.*

Wishart (John). Moment coefficients of the *k*-statistics in samples from a finite population. *Biometrika* (1952) **39**. 13p. 10¾″.

Zagoroff (S. D.). Rise and decline of peasant freedom in the Danubian countries. *Weltwirtsch. Arch.* (1952), **69**, 274–310. 9¼″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

VOL. CXVI.] [PART III

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART III, 1953.

Construction of an Index Number of Gilt-edged Values

By M. S. Rix

[Read before the Royal Statistical Society, March 25th, 1953,
Mr. E. C. Fieller, Vice-President, in the Chair]

1. summary

The object of this study is to review briefly existing indicators of movements in the gilt-edged market, and to explain the nature of redemption yields and therefore the limitations of price index numbers which include short-dated securities among their constituents. After discussing the use of yields instead of prices, it is suggested that the difficulty can be overcome by taking the reciprocals of redemption yields instead of the market quotations themselves. The result is an indicator of fluctuations in value in the special sense of the number of years' purchase of income from British Government securities, that income taking account of any capital gain or loss arising when a dated stock is paid off.

A series of geometric index numbers with base December 31st, 1948, has been computed at quarterly intervals from that date. Between 13 and 15 securities are used, divided into 4 groups according to the maturity of each stock as estimated from market price: 1 to 5 years; 5 to 15 years; all other dated stocks; and undated stocks. Though the groups carry equal weight in the present calculations, the final index is in principle a weighted average derived from strictly defined group index numbers the constituents of which are unweighted and of fluctuating composition. The results are then compared with existing price index numbers and related to the economic and market background of the 4-year period.

2. Some Existing Indicators

Existing material on movements in British Government stocks is of varied character. The Actuaries' Investment Index includes a price index (31.xii.38 = 100) of 2½ per cent. Consols, of 4 per cent. Consols together with 3½ per cent. Conversion, and of 4 per cent. Victory Bonds. Thus short-dated securities are excluded, and the 3 separate index numbers are not combined. *The Financial Times* publish daily a geometric index of Government securities (5.x.26 = 100) based on net market prices of 11 stocks which in December, 1952, were: 2½ and 4 per cent. Consols; 3½ per cent. Conversion and War Loans; 2½ per cent. National War Bonds 1951–53 and 1954–56; 3 per cent. National Defence Loan 1954–58; 3 per cent. 1959–69 and 4 per cent. 1960–90 Funding Loans; 3 per cent. Savings Bonds 1960–70; and 3 per cent. British Transport 1978–88.

The Actuaries' Investment Index for 2½ per cent. Consols only and *The Financial Times* for gilt-edged stocks in their index give also flat or running yields (that is, the percentage ratio of gross annual interest paid by the borrower to market price). The *Investors' Chronicle* in their monthly arithmetic price index (31.xii.23 = 100) show a group of 6 British Government securities from which short bonds are intentionally excluded: 2½ and 4 per cent. Consols; 3½ per cent. Conversion; 3 per cent. 1959–69 and 4 per cent. 1960–90 Funding Loans; and 3 per cent. Savings Bonds 1965–75. Yields are not published.

The *Monthly Digest of Statistics* (as at November, 1952) gives average prices of 2½ per cent. Consols and 3½ per cent. War Loan and also of one selected short bond (2¼ per cent. Exchequer

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Stock 1955, since January, 1950) and one selected long dated stock (3 per cent. Savings Bonds 1965–75 since January, 1951). Average flat yields are given on 2½ per cent. Consols, and on 3½ per cent. War Loan when this stock is below par, and redemption yields in other cases. Then each week *The Economist* quotes market prices and redemption yields for all the principal Government securities; in a few cases where there are optional dates the yields are given to earliest and to latest maturity. The privately-circulated *British Government Securities in the Twentieth Century* and its latest *Supplement* give prices and flat or redemption yields, as the case may be, at the end of each calendar year 1900–51 for each British Government stock. Finally, institutional investors receive daily prices and gilt-edged yields from certain brokers of whom they are clients.

There are unavoidable limitations, described in paragraph 3, upon price index numbers which include short- or medium-dated stocks. Hence such indicators are rare, and are used with caution. On the other hand, any price index which avoids these difficulties by restricting itself to 2½ per cent. Consols or similar stocks is no longer representative, and has not been representative for many years, of the course of gilt-edged values generally. It can be found from the *Supplement* to *British Government Securities in the Twentieth Century* that at March, 1952, for instance, undated stocks made up barely a quarter of the quoted direct and guaranteed Government debt. Moreover, three-quarters of that quarter consisted of 3½ per cent. War Loan, 3½ per cent. Conversion and 4 per cent. Consols which would in the heyday of cheap money have been regarded as redeemable.

No quoted British Government security is truly irredeemable. Most stocks are redeemable at or between optional dates and a few at fixed dates, while the stocks of the Funded Debt are repayable at Government option on or at any time after specified dates. "Old" Consols are perpetual only because we have come to assume that 2½ per cent. is at or below any likely minimum for long-term interest rates. In addition, changes in the yield differential between short- and long-dated securities are not shown up in price index numbers.

Both economists and institutional investors are therefore fully aware that it is necessary to study some indicator of dated as well as of undated stocks if they are to get a complete picture of the course of gilt-edged. This they do by examining lists of prices and redemption yields of individual securities, selections of which appear in the Press from time to time. Institutional investors have at their disposal at frequent intervals fullest details of what is after all not a very large number of securities, with the result that there is a lack of incentive to seek some measurement of the trend of the gilt-edged market as a whole.

But apart from a layman's difficulty in deciding which are the key stocks, it is hard to make comparisons over a period from selections of varying composition or irregular appearance. One object of an index number is to be able to make generalizations about diverse movements within a single field, and it is as legitimate to wish to make such generalizations about gilt-edged securities as about any other group of marketable commodities.

3. YIELDS TO REDEMPTION

To explain the unsuitability of traditional price index numbers for every class of gilt-edged we must digress to comment on the nature of redemption yields.

Wherever holders include dated securities in their portfolio but regard investment as a continuous process such that any sums arising from maturing stocks are reinvested, the mere market price or the running yield alone conveys little meaning. A running yield assumes that an income is received in perpetuity—a patent contradiction in the case of a dated stock. In the latter case the investor takes into account the capital sum he will receive from the borrower if he holds the stock until maturity. The market price is the sum of the market or present values of two separate rights: to an annual income during a fixed period and to a capital sum at the end of that period, the rate of compound interest being in either case the yield rate sought. Alternatively, investors regard themselves as amortizing the loss or gain on redemption out of current income. (The principles of calculation are set out in the Appendix.)

The importance of the theory of redemption yields for present purposes is that, for the same stock, such yields are more variable than running yields or prices. That is because the capital gain or loss is normally smaller than the market price, and hence shows greater variability in response to a given price change. A rise of 1 point in the price of a loan repayable at par from 95

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to 96 reduces the running yield by only 1/96th, but the capital gain on redemption is reduced by 1/5th. Thus a yield which includes an allowance for a capital gain or loss is more variable than the running yield which does not. The shorter the stock, the greater is the disparity between the two yields at any one price. For instance, a rise in price from 85 to 90 would reduce the percentage yield on 2½ per cent. Consols by less than 6 per cent., but for a 2½ per cent. 10-year bond the redemption yield would fall from 4·37 to 3·71 or by 15 per cent., and on a 5-year bond from 6·01 to 4·77 or by over 20 per cent.

In practice, it is the converse of this rule which is important—that a given proportionate change in yield results from a smaller price movement in a dated than in an undated stock. In the main, quotations for short bonds change much less than for longs: it is as if prices reflected changes in redemption yields, rather than showed independent movements of which redemption yields are only the arithmetical result. It is well known that large investors base their decisions when dealing in the gilt-edged market mainly on comparative yields appropriate to their particular cases, and not directly on price comparisons. Thus in 1951, when there were big changes in the market, the lowest prices of that year were only 2·6 per cent. below the highest for 2¼ per cent. Exchequer Bonds 1955 and 2·1 per cent. for 2½ per cent. National War Bonds 1952–54, whereas the corresponding falls for the long 3 per cent. Savings Bonds 1970–75 and the undated 2½ per cent. Consols were 15·1 and 15·9 per cent. respectively.

For the yield on 2½ per cent. Consols to rise from 3 to 3½ per cent., the price would fall from 83·3 to 71·4 or by 14 per cent., but for the same rise in a redemption yield from 3 to 3½ per cent., the price of a 2½ per cent. bond having 5 years to run would fall from 97·7 to 95·5, or by little more than 2 per cent. While an economist might reasonably regard both stocks as having fallen in value to the same extent of one-seventh (due, that is, to a rise of one-sixth in yield, from 3 to 3½ per cent.), a simple average of the two prices at the two dates would reveal a fall of only 8 per cent. The conclusion is that quite large changes in the redemption yields of dated stocks and their value in the eyes of investors cannot produce corresponding changes in price index numbers. Such indicators underrate the true variations in dated stocks (especially short bonds) which now make up the greater part of the market, and hence they understate variations in gilt-edged values as a whole.

4. Gross and Net Yields

Throughout this paper discussion is limited to gross redemption yields, which take no account of tax payable on the current income from a security. Large investors adopt a more realistic point of view; they calculate net redemption yields, using the same principles but allowing for the fact that current income is received net, while the capital gain or loss is gross. Thus with tax at 7*s.* 6*d.* in the £, a 3 per cent. loan is treated as if it were a 1⅞ per cent. stock. Users of such yields argue that it is misleading to put capital and income on the same footing in redemption yield calculations if in practice they receive different treatment.

Net yields have been calculated for comparison with gross redemption yields for three selected stocks, and appear in Table 2 and in the trial index in Table 3 of the Appendix. While net yields are always smaller, the ratio between the gross and net figures is variable. The capital gain or loss carries greater weight compared with income in net than in gross yields, so that net redemption yields are considerably more variable than gross, just as the latter are more variable than running yields.

Otherwise the present calculations have been confined to gross yields because only gross yields are independent of individual circumstances. There seems to be no decisive evidence that investors subject to any particular rate of tax are responsible for movements in the gilt-edged market as a whole. Indeed, net redemption yields show such vagaries, especially in short-dated stocks looked at over short and disturbed periods, that we are justified in assuming that such yields are not the chief motive force. Quite apart from the varying tax liabilities of private persons, there are large differences in the tax status of important institutional investors. Insurance offices pay 7*s.* 6*d.* on the investment income of life funds, companies pay 9*s.* 6*d.* and sometimes Profits Tax as well, pension funds pay no tax at all, while the money market and certain other institutions pay tax on profits in which capital and income are treated alike. A basis of calculation which is essential to a particular class of investor has therefore been regarded as unsuitable when surveying the market as a whole.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

5. The Yield Principle in Index Numbers

Now a price index aims at measuring changes in the money cost of the same group of commodities, or of a changing group of commodities fulfilling as nearly as possible a constant purpose. It can be argued that the main object of a gilt-edged index number is to measure changes in the cost of acquiring income from the marketable debt of the British Government. That is at any rate what is meant in speaking of tendencies towards cheap or dear money, so far as marketable securities are concerned. In fact, writers often prefer to use the expressions dear or cheap money, rather than low or high prices, and are often forced to speak of changes in the yield basis when discussion of prices alone would be misleading. On this interpretation, price index numbers of perpetual fixed interest stocks are used largely to measure variations in yield.

Price index numbers based on $2\frac{1}{2}$ per cent. Consols or perpetual debentures or preference shares show changes in the cost of securing an unchanging income. And price indices, such as those quoted in Table 3 of the Appendix, could be arrived at by taking (instead of price) variations in the number of years' purchase of the running yield of each security in the index, or in the reciprocal of each running yield. The calculation of yields in constructing such an index is merely superfluous, as the amount of income entering into the computations is by definition constant, and cancels out in comparing any two periods.

The yield approach is however the one adopted here in considering the value of gilt-edged stocks, redemption yields being used for dated issues, and prices or running yields for undated stocks. The result is an indicator of changes in the capital value in the market of a constant yield from the same or as nearly as possible the same securities. It is not worked out direct from market prices, but from yields calculated from those prices and from the apparent life of each stock at the date of each computation. It is an index of changes in the number of years' purchase of yields, and is for convenience described as an index of values, though it is not a price index.

It cannot be used for comparing the actual capital appreciation or depreciation on a particular portfolio of gilt-edged stocks with changes in the gilt-edged market generally. But a gilt-edged price index does not seem to be suitable for that purpose either. With so many different classes of investor, there is no such thing as a typical group of gilt-edged holdings with constituents similar to those of a price index.

The argument here is merely that if £100 money produces an annual rate of income of £3 10*s.* at date $_0$ and £4 at date $_1$, the cost of producing £1 of income (after allowing for a sinking fund to provide any capital loss or gain on maturity) has fallen from £28·6 to £25, or by one-eighth. In practice the redemption yield reciprocals which form the material for this index are not recorded, the relatives being worked so as to include the base yield in the numerator of the fraction, thus:

$$\frac{\text{Base redemption yield per cent.}}{\text{Current redemption yield per cent.}} \times 100.$$

The yield approach in the study of changes in market value is not a complete innovation. *British Government Securities in the Twentieth Century* includes, for instance, a chart of average yields for different groups of gilt-edged, though these would not, even if the same grouping and constituents were used, give the same results as in the present index, since the reciprocal of the arithmetic average yields would give the harmonic mean of values.

The Industrial Dividend index of the *Investors' Chronicle* is calculated monthly from the Actuaries' Investment Index and yields. Also Mr. A. G. Ellinger's Confidence Indicator (constructed to show a rise when the yield differential between fixed interest stocks and equities is contracting and a fall when it is increasing) is based on the following formula, in which FT represents the *Financial Times:*

$$\frac{100{,}000}{\text{FT Fixed Interest Index} \times \text{FT Ordinary Yield}}.$$

(The fixed interest price index is used instead of yield in the denominator of this fraction, because the income on such stocks cancels out when comparing the situation at different dates). The *Investors' Chronicle* Industrial Dividend index is aimed at revealing dividend changes, and the Confidence Indicator at eliminating fluctuations in dividend and in the rate of interest. In fact, resort has to be had to yields in all cases where correct inferences cannot be drawn from unadjusted

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

price index numbers. The present gilt-edged indicator is only an extension of a principle already in use in other fields.

6. The Constituent Gilt-edged Stocks

At the beginning of September, 1952, there were 59 issues of direct and guaranteed Government debt quoted in the *Stock Exchange Daily Official List*, and counting the Serial Funding stocks as a single issue, 31 of these were of £100 millions nominal or over. The index aims at including a fluctuating number, between a half and a third, or 10 to 15 of these larger issues. Any issues of recognized market importance are included, such as 3½ per cent. War Loan, 3 per cent. British Transport 1978–88 and 2½ per cent. Consols. To keep the index representative, newly-issued stocks are brought in if presenting some new characteristic, such as the 3 per cent. Funding Stock 1966–68, with its narrow dates. As much variety as possible is aimed at in the maturity, in the spread between two optional dates, and in coupon rate. Bonds having less than 1 year to run are excluded, as they are more akin to bills than to marketable securities in the usual sense.

7. Maturities

Since redemption yields as calculated by investors are based on current market price and on what the market believes the life of the stock to be, market expectation of the date of maturity and not necessarily the final date is used throughout this paper.

All British Government securities are repayable at par, a few of them having a sinking fund. The customary rule (as adopted, for instance, in the calculations quoted in the *Monthly Digest*) is that if the current price is above par, the borrower will repay the loan at the earlier of two optional dates, because in the light of current conditions he is expected then to be able to renew the debt on terms more favourable to him. If the stock is below par, indicating that money has become dearer, he is expected to repay his debt only when compelled—that is, at the final date. On the same principle, a stock with no final date but repayable at Government option is regarded as perpetual if below par, but if above par it will be paid off as soon as the terms of issue allow.

Yet too strict adherence to this way of estimating date can, exceptionally, lead to freak results. It is, for instance, unrealistic to keep changing the assumed date of repayment from day-to-day or week-to-week when prices of stocks with optional dates are fluctuating within narrow limits on either side of par. Or, in times of unusual disturbance in money rates, the future action of the borrower may become quite unpredictable, within the limits laid down by the terms of issue. And in the present index the middle price between quotations separated by as much as one or two whole points is not always representative of prices at which business is done, and can give rise perhaps to a wrong choice of date. It is noteworthy that the compilers of *British Government Securities in the Twentieth Century*, as can be seen from the 1950 volume and its recent *Supplement*, had after 1948 to cease following the orthodox rule as an invariable practice. In the latter part of 1949, for instance, the strict rule would occasionally have yielded results which misrepresented the market's actual beliefs as gauged from other evidence.

To be consistent, the orthodox procedure for estimating date has been used throughout this paper, though even here, where calculation at only quarterly intervals reduces the problem to a minimum, it has been found necessary (as described in the Appendix) to reject assumptions giving rise to freak results. In the September, 1950, index, for example, 2¾ per cent. Funding Stock 1952–57 was altered from a 1952 to a 1957 maturity, although the net price was well above par. It must be stressed that *any* date within the terms of issue can be used, so long as it fairly represents the maturity in the minds of representative buyers on the day in question, and so long as the necessary adjustments to the base yield are made after changing the assumed date of repayment.

8. Grouping and the Problem of Weights

Although some compromise has been reached by excluding the small issues, weighting by size, either of nominal amount or valuation at any one date, and whether of individual stocks or classes, has been rejected. This is because amounts in issue are no guide to the stocks, which for the time being account for most of the turnover or which are leading the changes in prices. There is no analogy with a price index of consumer goods, where the importance of a variation in price depends largely on typical expenditure on the goods in question. Weighting by size, or a simple market valuation of all British Government stocks, would assign small significance to stocks such

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

as 2½ per cent. Consols which are important without being particularly large, and give too large a weight to the group of stocks redeemable finally within about 15 years, or to individual securities such as 3½ per cent. War Loan and the 1960–70 and 1965–75 issues of 3 per cent. Savings Bonds.

Instead, the principle has been followed of using arbitrary weights, though in the present index the four groups (according to apparent life) are equally weighted. The constituents within each group are unweighted, the composition of any one class being liable to frequent change. Indeed, the group index for short-dated securities is at times little better than a chain index. Not more than 5 stocks go into any one group, not because there is any objection to a larger number, but because in an index having not more than 15 items in all, to have more than, say, 5 in any one class would imply that the remaining categories did not contain enough securities to be representative, or that the grouping itself was unsuitable.

The groups, too, may seem somewhat arbitrary, but they should fairly represent classifications of recognized importance. No system of grouping can be really permanent, because of the passing of time, or because the type of stock issued by the Government changes so that some classes lose their importance, while others such as the short bonds issued during the war come into prominence.

In the present index a key group is that for short bonds, having a currency of at least 1 year but under 5 years. Apart from the market interest in such bonds, there is a technical reason for treating them apart. Any dated stock must sooner or later become a short, and normally, though not invariably, short bonds yield less than longs. Thus a series of redemption yields of any one stock would, other things being equal, in the last few years of its life show a rise in the index. This rise would be a reflection, not of any improvement in Government credit, but merely of the automatic change in the character of the stock. The difficulty is overcome by recognizing shorts as a distinct category to include not only securities originally issued as shorts but any others which have become short through lapse of time. Shorts are also taken to include any stock of the Funded Debt standing above par and optionally repayable within 5 years. It has been pointed out by Mr. W. Prater that the money market would not regard any such stock as a true short, and that the Funded Debt should preferably be divided into stocks like 2½ per cent. Consols, which the market regard as irredeemable, and any which are for the time being treated as dated (such as 4 per cent. Consols in 1948) because they stand above the redemption price. While it would be desirable to make such a distinction if there were a prolonged return to cheap money, the period affected in the present index was not thought long enough to warrant the creation of a new class.

The second group chosen consists of stocks with a life of at least 5 but under 15 years, the short-medium and medium category. It might be argued that there is not much in common between two stocks having maturities say of 5½ and 14½ years, but there did not seem enough stocks in the 10–15 year class to require the formation of a separate group.

Thirdly, there are all other dated stocks, having maturities of 15 years and upwards. It is rather a hotch-potch, including at one extreme 2½ per cent. Savings Bonds 1964–67 (until March, 1952, after which these passed into the next shorter category), and at the other 3 per cent. British Transport 1978–88, which is a long but none the less a dated stock. There had to be a dividing line somewhere between dated and undated stocks, and it was thought that a separate category for really long dates of say over 25 years would be of little interest. The selection made has aimed at stocks of the medium-long rather than the very long type, with this one exception.

The fourth and last group consists of undated stocks, undated, that is, in the market's opinion. The group includes throughout 2½ per cent. Consols and 2½ per cent. Treasury Stock 1975 or after, while 3½ per cent. War Loan and 4 per cent. Consols have been treated as dated stocks before September, 1949 and March, 1951 respectively, and undated subsequently.

An alternative method of grouping by final maturity has the advantage of remaining relatively constant for a few years, but it is unrealistic in times of cheap money when there are many stocks standing above par so that repayment at some earlier date is to be expected. By lapse of time stocks classified in that way are constantly passing into shorter categories, whereas in times of dear money some of them really become longer and not shorter.

A system of grouping in accordance with market expectation of maturity means a greater but more realistic shifting in the composition of the separate classes. Stocks pass from one group to another because of a major change in price, or because of lapse of time, while securities have to be added or dropped. Or, without a change in group, an alteration in price may cause some

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

change to be made in the assumption about the date of repayment. Because of changes like these, emphasis has to be on preserving the continuity of the group index numbers, at the expense of the relatives for separate securities. These difficulties are inherent in the nature of an index such as this and have to be dealt with by the usual method of linking, adapted to redemption yields in accordance with the illustrations given in the Appendix.

9. Comparisons and Conclusions

The Appendix sets out in more technical detail the methods already explained, and includes three tables presenting the results of this inquiry. Table 1 gives the middle market prices, adjusted for net accrued interest, shown in the order of the *Official List*. Table 2 gives the group constituents (in the order in which they come into the group), the same constituents appearing under more than one heading where they fall into different categories at different times. The up-to-date constituents are therefore those for which yields are given in the last column. Because of frequent resort to linking, an unbroken series of relatives cannot in most cases be calculated directly from the printed yields. The actual results appear in Table 3, together with existing price index numbers at approximately the same dates, and converted to end—1948 = 100. Too much stress should not be put on minor contrasts between the different indicators, as they do not all refer to precisely the same dates, but taken as a whole, they are on a comparable basis. The group and final index numbers are also shown in chart form on page 244.

The present and the published index numbers are set out in descending order of sensitiveness. The least variable is that of the *Financial Times*, since it includes shorts and other dated stocks whose prices move less than the undated for any given change in yield. The drop in the first half of 1952 appears to be rather less than in 2½ per cent. Consols, although it is conceded that after the 1952 Budget shorts fell in value more than longs.

As would be expected, the *Investors' Chronicle* British Funds index with its mixture of undated and fairly long-dated stocks is intermediate between the *Financial Times* and the Actuaries' Index of 4 per cent. Consols and 3½ per cent. Conversion, corresponding on the whole closely with the latter, especially as these two stocks are also contained in the *Investors' Chronicle* index. The slight divergence in 1952 is presumably because prices of the stocks used by the *Investors' Chronicle* were a little more insensitive because of the inclusion of dated securities.

The most sensitive of the published price index numbers is the Actuaries' for 2½ per cent. Consols, where there is no redemption date to damp down price movements. Thus we have the paradox that when price index numbers are used, the undated securities appear to be more variable than the dated, although the market knows that is not the case when yields are taken into account, especially on short bonds. The 2½ per cent. Consols index, however, is representative of only one class of stock, and by itself contains no hint of the changes that sometimes occur in the yield differential between different types of gilt-edged.

The new index for the undated group corresponds, of course, closely with the Actuaries' for 2½ per cent. Consols, the only appreciable difference occurring in June, 1951, when the 2½ per cent. Treasury Stock and 4 per cent. Consols did not fall quite so heavily as 2½ per cent. Consols.

The new index numbers can now be related to the market background. The whole of 1948 and most of the first half of 1949 were uneventful, until fears that balance of payments difficulties would force the devaluation of sterling caused a sharp fall in prices. No class of gilt-edged was immune, but after devaluation in September, 1949, stocks of short-medium date or longer did not show any striking persistent trend in the following 15 months.

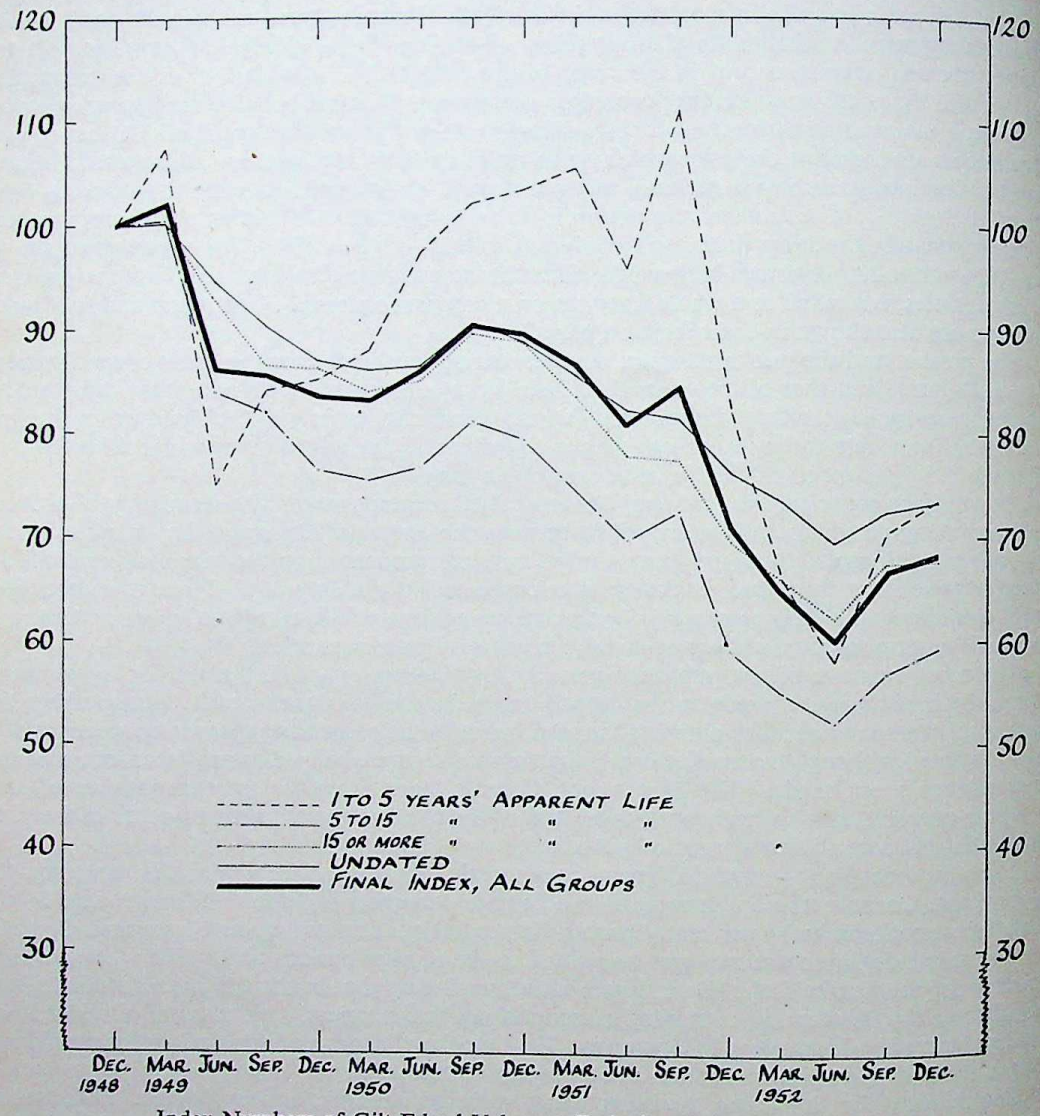
The demand for shorts, on the other hand, gathered strength, and by March, 1951, values were markedly higher than just after devaluation although other categories of gilt-edged were lower. During the latter part of 1950 the market had realized that the gold and dollar position should be eased by the earnings of the Colonial territories, able to sell commodities at dollar prices mounting under the pressure of the Korean war. It is possible that the strength of shorts in the 12 months or so following devaluation was due to the rising trend of the sterling balances and our improving dollar account.

Right at the end of 1950 there was a tendency for gilt-edged stocks to weaken as the Korean war was not developing as expected, but the main characteristic of the winter of 1950–51 was the situation arising from the nationalization of steel shares. Compensation of known amount was

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to be paid in Iron and Steel stock of an unknown but presumably long-dated type. Steel shares stood at a small discount on their take-over prices, and were widely bought as an indirect way of purchasing gilt-edged. In consequence the longer existing British Government securities were neglected—a neglect accentuated by the growing preference for equities which began slowly in the latter part of 1950—and there was even understood to be some switching out of gilt-edged into steel shares. Shorts, on the other hand, were immune from this trend, and it is hard to say whether, without steel nationalization, shorts and longs would have diverged at all.



Index Numbers of Gilt Edged Values at End of each Quarter, 1949–52
(1/Gross Redemption Yield, 31.12.48 = 100)

The spring of 1951 saw investors getting seriously worried about inflation, and there soon developed a strong demand for equities to the detriment of gilt-edged. The 1951 Budget, with its statement that Exchequer contributions to the National Insurance Funds would be reduced so that the Funds would not continue to add to their surplus, confirmed the market's belief that falling gilt-edged prices would not be officially supported. The result was that all classes of gilt-edged weakened, shorts included.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

But before the Election doubts about future monetary policy, and the ability of the future Government to combat inflation, induced investors to take refuge from uncertainty by investment in shorts as a temporary outlet for funds. Short bonds rose very sharply in the third quarter of 1951, the short-medium group also being affected. After the Election, the new Chancellor's dearer money policy and the increase in Bank Rate, the holders of the shorter-dated stocks were badly caught and saw a drastic fall in the current value of their holdings—a fall which could, however, be nullified by holding the stocks until maturity. Other classes also were hard-hit, though not to the same extent: yield differentials narrowed, and the shorter the stock the worse was the fall in value as measured by the rise in yield.

The March, 1952, Budget brought almost a repetition of these reactions. Shorts fell severely, the longer-dated stocks weakening too but to a smaller degree. At the same time, too much should not be made of the weakness in short bonds beginning in the autumn of 1951. If they fell more than longs, they fell from greater heights.

The late summer of 1952 then saw a marked recovery, which persisted at a considerably slower rate in the fourth quarter, the general tendency seeming to be towards a restoration of the end-1951 position.

Acknowledgments

My thanks are due for permission, on behalf of the Institute of Actuaries and the Faculty of Actuaries to describe the relevant sections of their Investment Index, by Mr. A. G. Ellinger to reproduce the formula for his Confidence Indicator, and by the Editors of the *Financial Times* and the *Investors' Chronicle* to give the main details of their Government securities index numbers. I am also much indebted to the compilers of *British Government Securities in the Twentieth Century* for explanations and comments upon technical matters and in particular upon the difficulties of determining the life of short-dated stocks in periods of changing interest rates.

APPENDIX

Redemption Yields

i = required redemption yield, or rate of interest on money invested.

C = current or market value of the security.

R = redemption value of the security.

D = dividend or interest receivable in each term.

$v^n = \dfrac{1}{(1 + i)^n}$ = present value of 1 at end of n terms at rate i.

$a_n = \dfrac{1 - v^n}{i}$ = present value of an annuity of 1 for n terms at rate i.

$S_n = \dfrac{(1 + i)^n - 1}{i}$ = amount of an annuity of 1 at end of n terms at rate i.

k = proportionate loss (+) or gain (−) on redemption $= \dfrac{C - R}{R}$.

$g = \dfrac{D}{R}$ = nominal rate of interest where R is par.

Redemption yields are calculated from compound interest tables using interpolation methods. (From this, tables are also available showing prices at different nominal rates of interest, life, and redemption yield.)

Formula (A):

$$C = R \,.\, v^n + D \,.\, a_n.$$

This merely expresses in symbols the fact that price must be equal to the present values of the interest payments and of the capital payment at redemption. In any given case, values of C can be obtained from compound interest tables for different values of i, the redemption yield being found by simple interpolation of actual price between values of C at two trial rates of i.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The formula can be transformed into—

(B): $$i = \frac{D - \frac{C - R}{S_n}}{C} = \frac{g - \frac{k}{S_n}}{1 + k}.$$

Since S_n must be calculated at rate i, this does not provide a direct calculation of i, but it does give an approximation which will suggest the values to be taken for the interpolation.

Formula (B) also illustrates the sinking fund concept, and the greater variability with changes in k of the redemption yield i than of the running yield $\frac{g}{1+k}$, since the numerator of the fraction changes more than the denominator.

This variability is greater the shorter the stock (since S_n/S_{n-1} increases as n falls), or, as with net redemption yields, the lower the value of g relative to the other factors.

Example.—A $2\frac{1}{2}$ per cent. stock (half-yearly interest) repayable at par in 10 years costs 91·62 $C = 91{\cdot}62$; $k = 8{\cdot}38$; $n = 20$ half-years; $D = 1{\cdot}25$ per cent. and $i = 1{\cdot}75$ per cent. per half-year.

Formula (A):

$$(100 \times {\cdot}70682) + (1{\cdot}25 \times 16{\cdot}753) = 91{\cdot}62.$$

Formula (B):

$$3\tfrac{1}{2} \text{ per cent. p.a.} = {\cdot}0175 \text{ per term} = \frac{{\cdot}0125 - \frac{{\cdot}0838}{23{\cdot}7016}}{{\cdot}9162}.$$

Construction of the Index

The middle prices of the quotations in the *Stock Exchange Daily Official List* are used. Except for bonds having less than 5 years exactly to final maturity (where buyers pay or receive interest separately), interest less income tax at the standard rate accrued from the last interest payment is deducted, or, if the stock is marked ex dividend, such interest up to the date of the forthcoming payment is added. From the resulting net price, gross redemption yields are found by interpolation from tables applicable to stocks on which interest is paid half-yearly. Percentage yields are recorded to 3 figures in Table 2, but are worked to 4 figures for the calculation of the relatives.

Each stock at each date is assumed to mature on the last date of repayment if the redemption price exceeds the net price, or at the earliest date if the net price is the higher. For stocks repayable at Government option only, the yield to earliest redemption is used if the price exceeds par, and the running yield if the price is under par. But the contrary assumption is used if this normal rule gives a relative which differs from the average for the rest of the group by 20 per cent or more.

For each dated stock, relatives are worked thus:

$$100 \times \frac{\text{gross actual or notional redemption yield per cent. at base date}}{\text{gross redemption yield per cent. at current date}}.$$

The base redemption yield is that at 31.xii.48, or is a notional yield calculated in accordance with the linking procedure described below. Simple price relatives (with base 31.xii.48 = 100, or notional base) are used for undated stocks, as this gives the same result as an index based on running yields.

For each group the geometric mean of the separate relatives is calculated, and the final index is the geometric mean of the 4 groups, each having equal weight. The geometric mean has been chosen to avoid distortion due to selection of a particular base date.

The life of each stock is the time elapsing between the date of each index and the date of repayment, or maturity, estimated as above. The stocks are then grouped according to life:

(A) With a life of at least 1 but under 5 years.
(B) ,, ,, 5 ,, 15 ,,
(C) All other dated stocks, with a life of 15 years and over.
(D) Undated stocks (that is, when the market price indicates that the stock will not be paid off at any time).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 1

Constituents and Net Prices

Stock and Maturity.	1948. 31 *Dec.*	1949. 31 *Mar.*	30 *June.*	30 *Sep.*	30 *Dec.*	1950. 31 *Mar.*	30 *June.*	29 *Sep.*	29 *Dec.*	1951. 30 *Mar.*	29 *June.*	28 *Sep.*	31 *Dec.*	1952. 28 *Mar.*	30 *June.*	30 *Sep.*	31 *Dec.*
2½% Consols (since 5 Apr., 1923)	80·02	80·02	75·52	73·02	70·02	69·02	69·02	72·52	71·03	68·52	65·02	65·02	61·52	59·53	56·02	58·52	58·52
4% „ (1 Feb., 1957 or after)	109·69	109·65	106·19	105·14	101·70	101·65	102·19	104·14	102·71	100·91	98·19	97·17	90·18	87·68	82·68	85·65	87·18
2½% Exchequer Stock 1955 (15 Feb.)	—	—	—	—	—	—	100·87	101·50	101·62	101·75	100·87	101·75	99·62	97·75	96·75	98·50	98·75
2½% Funding Loan 1956–61 (15 Apr.)	101·71	101·56	98·71	99·06	98·71	98·56	98·71	99·56	99·47	98·06	96·48	97·06	92·47	90·56	89·23	92·05	93·22
2½% „ „ 1952–57 (15 June)	102·93	103·56	100·94	102·06	101·44	101·56	101·94	102·31	102·19	101·81	100·94	101·83	98·94	98·09	96·50	99·00	99·75
3½% „ Stock 1966–68 (1 Aug.)	—	—	—	—	—	—	—	—	—	97·49	93·64	93·75	88·14	85·76	82·64	87·24	87·64
4% „ Loan 1960–90 (1 May)	114·14	113·69	109·64	108·19	106·64	105·69	106·14	107·45	106·90	104·44	102·41	102·95	—	—	—	—	—
3% National Defence Loan 1954–58 (15 July)	105·07	105·16	101·57	102·65	102·57	102·66	103·07	103·16	103·08	103·17	101·82	103·18	99·56	98·18	97·56	99·17	100·31
2½% National War Bonds 1952–54 (1 Mar.)	102·79	102·62	100·62	101·00	101·37	101·25	101·87	102·25	101·62	101·50	101·00	101·37	99·87	98·75	98·25	99·25	99·75
2½% „ „ „ 1954–56 (15 Aug.)	—	—	—	100·83	100·98	101·33	102·24	102·08	102·49	102·34	102·02	102·25	99·62	97·50	95·75	98·75	98·75
2½% Savings Bonds 1964–67 (1 May)	98·77	98·62	95·27	93·12	93·28	92·12	93·27	94·87	94·28	91·87	89·78	89·63	85·28	82·62	80·29	83·61	84·28
3% „ „ 1960–70 (1 Sep.)	102·95	102·86	99·45	96·37	96·46	94·86	95·95	98·12	98·21	95·12	91·98	91·88	86·73	83·88	80·98	84·88	85·48
3% „ „ 1965–75 (15 Aug.)	102·38	102·30	98·89	93·79	94·38	93·30	93·39	96·55	96·39	93·06	89·67	89·31	83·65	81·32	78·42	82·80	83·40
2½% Treasury Stock (1 Apr. 1975 or after)	79·16	79·50	75·16	71·00	68·66	68·00	68·66	72·51	70·67	67·51	64·68	64·01	59·67	57·51	54·18	56·50	57·67
3½% War Loan (1 Dec. 1952 or after)	103·34	103·62	100·34	95·36	92·34	91·37	91·84	95·62	94·10	91·37	87·36	86·15	80·85	77·41	73·25	76·89	77·85
3% British Transport Gtd. Stock 1978–88 (1 July)	100·50	101·10	96·00	91·57	90·01	88·60	88·50	93·09	91·51	88·10	83·51	82·87	77·50	76·12	73·00	77·61	77·00

Note.—Stocks are in alphabetical and coupon rate order. Prices are not shown for the link period or any other date at which they do not enter into the final index.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Group Constituents and Gross Redemption Yields per cent.

Stocks (grouped by apparent side).	1948. 31 Dec.	1949. 31 Mar.	1949. 30 June.	1949. 30 Sep.	1949. 30 Dec.	1950. 31 Mar.	1950. 30 June.	1950. 29 Sep.	1950. 29 Dec.	1951. 30 Mar.	1951. 29 June.	1951. 28 Sep.	1951. 31 Dec.	1952. 28 Mar.	1952. 30 June.	1952. 30 Sep.	1952. 31 Dec.
Group (A): 1 but under 5 years:																	
2¾% Funding Loan 1952–57	1·87	1·61	2·42	1·96	2·15	2·02	1·74	(a)	—	—	—	—	—	—	3·53	2·98	2·81
2½% National War Bonds 1952–54 Net(e)	*0·67*	*0·65*	*1·32*	*1·14*	*0·92*	*0·90*‖	*1·04*	*0·89*	*1·04*	*1·04*	*1·18*	*0·98*	*1·62*	*2·23*	*2·64*	*2·10*	*1·78*
2½% National War Bonds 1952–54 Gross	1·59	1·58	2·26	2·07	1·85	1·83‖	1·97	1·82	1·97	1·97	2·11	1·92	2·56	3·18	3·59	3·04	2·72
3½% War Loan (1952 or after)	2·60	2·46	3·39	(a)	—	—	—	—	—	—	—	—	—	—	—	—	—
2½% National War Bonds 1954–56	(b)	—	—	2·32	2·28	2·18	1·93	1·94	1·79	1·78	1·83	1·70‖	2·59	3·12	3·62	2·84	2·87
3% National Defence Loan 1954–58	(a)	—	—	2·41	2·40	2·34	2·20	2·13	2·09	2·00	2·38	1·83	(a)	—	—	—	—
2½% Exchequer Stock 1955	(b)	—	—	—	—	—	2·05	1·89	1·84	1·78	2·00	1·71	2·37	3·07	3·56	2·91	2·86
Group (B): 5 but under 15 years:																	
4% Consols (1957 or after)	2·64	2·63	3·08	3·21	3·73	3·72	3·62	3·27	3·50	3·82	(a)	—	—	—	—	—	—
2½% Funding Loan 1956–61 Net(e)	*1·32*	*1·33*‖	*1·68*	*1·65*	*1·69*	*1·71*	*1·69*	*1·61*	*1·62*	*1·77*	*1·96*	*1·90*	*2·48*	*2·75*	*2·96*	*2·61*	*2·47*
2½% Funding Loan 1956–61 Gross	2·24	2·26‖	2·63	2·60	2·63	2·65	2·64	2·55	2·56	2·72	2·92	2·86	3·45	3·74	3·96	3·59	3·45
4% Funding Loan 1960–90	2·55	2·57	2·95	3·09	3·24	3·33	3·26	3·09	3·14	3·43	3·68	3·60	(b)	—	—	—	—
3% National Defence Loan 1954–58	2·03	1·97	2·66	(a)	—	—	—	—	—	—	—	(c)	‖3·07	3·32	3·45	3·16	2·94
3% Savings Bonds 1960–70	2·70	2·71	(a)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2¾% Funding Loan 1952–57	—	—	—	—	—	—	(c)	‖2·38	2·38	2·43	2·58	2·40	2·96	3·15	(a)	—	—
2½% Savings Bonds 1964–67	—	—	—	—	—	—	—	—	—	—	—	—	—	(c)	4·31	3·99	3·95
Group (C): 15 years or more:																	
2½% Savings Bonds 1964–67	2·58	2·60	2·84	3·01	3·00	3·10	3·01	2·89	2·94	3·15	3·34	3·36	3·77	4·05	(a)	—	—
3% „ „ 1965–75 Net(e)	*1·71*	*1·71*‖	*1·93*	*2·19*	*2·16*	*2·22*	*2·22*	*2·05*	*2·06*	*2·25*	*2·44*	*2·47*	*2·83*	*2·99*	*3·21*	*2·91*	*2·88*
3% „ „ 1965–75 Gross	2·82	2·82‖	3·06	3·36	3·33	3·40	3·39	3·20	3·21	3·42	3·65	3·68	4·09	4·27	4·51	4·17	4·14
3% British Transport Gtd. 1978–88	2·97	2·94‖	3·18	3·39	3·47	3·55	3·55	3·32	3·40	3·58	3·84	3·88	4·21	4·31	4·53	4·22	4·26
3% Savings Bonds 1960–70	—	(c) ‖	3·04	3·24	3·24	3·35	3·28	3·13	3·12	3·34	3·58	3·59	4·02	4·27	4·55	4·21	4·17
3% Funding Stock 1966–68	(b)	—	—	—	—	—	—	—	—	3·19	3·50	3·49	3·98	4·21	4·53	4·10	4·08
Group (D): Undated(d):																	
2½% Consols	3·12	3·12	3·31	3·42	3·57	3·62	3·62	3·45	3·52	3·65	3·85	3·85	4·06	4·20	4·46	4·27	4·27
2½% Treasury Stock (1975 or after)	3·16	3·14	3·33	3·52	3·64	3·68	3·64	3·45	3·54	3·70	3·86	3·90	4·19	4·35	4·61	4·42	4·33
3½% War Loan (1952 or after)	—	—	(c)	3·67	3·79	3·83	3·81	3·66	3·72	3·83	4·01	4·06	4·33	4·52	4·77	4·55	4·50
4% Consols (1957 or after)	—	—	—	—	—	—	—	—	—	(c)	4·07	4·12	4·44	4·56	4·84	4·67	4·59

(a) Appears in another group at this and some subsequent dates.
(b) Removed from or not yet added to list of constituents.
(c) Appears in another group at this and previous dates.
(d) Running yields are given.
(e) For illustration: assumes tax at 7*s.* 6*d.* deducted from current interest.
‖ Indicates a change in the assumed maturity, with or without a change of group.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 3

Index Numbers of Gilt-edged Stocks

(End 1948 = 100)

Index.	1948. 31 *Dec.*	1949. 31 *Mar.*	1949. 30 *June.*	1949. 30 *Sep.*	1949. 30 *Dec.*	1950. 31 *Mar.*	1950. 30 *June.*	1950. 29 *Sep.*	1950. 29 *Dec.*	1951. 30 *Mar.*	1951. 29 *June.*	1951. 28 *Sep.*	1951. 31 *Dec.*	1952. 28 *Mar.*	1952. 30 *June.*	1952. 30 *Sep.*	1952. 31 *Dec.*
Trial index for 3 stocks(a):																	
1/ net redemption yield	100·0	100·4	72·8	73·8	79·0	78·6	83·6	91·7	80·4	81·8	73·8	78·8	58·5	49·8	44·5	52·2	56·4
1/ gross ,, ,,	100·0	100·1	83·8	83·8	87·1	86·5	89·5	94·7	92·0	88·3	82·5	85·6	70·4	62·8	58·2	65·1	68·8
Values (1/ gross redemption yield):																	
(A) 1 but under 5 years' apparent life	100·0	107·5	74·9	84·2	85·2	88·1	97·6	102·3	103·5	105·6	95·9	111·2	82·4	66·1	58·0	70·4	73·6
(B) 5 ,, 15 ,, ,,	100·0	100·4	84·0	82·1	76·5	75·5	76·9	81·2	79·4	74·5	69·8	72·5	59·1	55·0	52·1	56·9	59·3
(C) 15 years or more ,, ,,	100·0	100·2	92·9	86·6	86·4	84·1	85·2	89·8	88·8	83·6	77·9	77·5	69·5	66·0	62·1	67·4	67·7
(D) Undated	100·0	100·2	94·7	90·3	87·1	86·2	86·6	90·8	89·0	85·7	82·2	81·5	76·3	73·6	69·4	72·4	73·4
Final index	100·0	102·0	86·2	85·7	83·7	83·3	86·2	90·7	89·8	86·7	80·9	84·5	71·3	64·8	60·1	66·5	68·2
Prices(b):																	
Actuaries' Investment Index(c)—																	
2½% Consols	100·0	100·7	93·8	90·7	88·2	86·3	85·9	90·0	88·8	85·0	80·5	81·9	76·9	74·4	69·4	73·2	73·2
4% Consols and 3½% Conversion	100·0	100·1	95·7	93·1	90·7	89·5	90·8	92·7	92·0	89·1	86·2	85·9	79·1	76·5	72·4	75·4	76·2
Investors' Chronicle(d)—																	
British Funds	100·0	99·7	97·1	92·5	90·9	89·7	92·8	92·8	92·2	89·5	86·5	85·8	80·9	78·1	75·0	77·4	79·0
Financial Times—																	
Government Securities	100·0	100·1	96·4	94·0	92·9	92·1	92·7	94·8	94·1	92·2	89·4	89·2	84·4	82·3	79·6	82·5	83·1

(a) Three selected dated stocks (2½% National War Bonds 1952–54 and Funding Loan 1956–61, and 3% Savings Bonds 1965–75), to illustrate variability of gross and net (tax at 7*s.* 6*d.*) redemption yields.
(b) Published index numbers converted to end 1948 = 100.
(c) As at last Tuesday in each month.
(d) Near end of month, published in first issue of following month.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar
Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

Linking

(1) The base redemption yield is a notional figure for any stock added, substituted or transferred from another group, such that it leaves the original group index number unaltered in the link period. (2) Similarly within a group, if an assumption as to maturity is changed, the base redemption yield is altered so that the redemption yield to the new maturity in the link period gives the same relative as before. (3) Where the number of stocks in a group is reduced either by transfer to another class or complete removal, the current and future index numbers for the group are multiplied by a factor such that in the link period the index number with the reduced number of constituents would be the same as before. (4) When a stock is added to a group reduced in size in an earlier period as in (3), the notional base yield is calculated so as to eliminate the adjusting factor and leave the group index unchanged.

Examples:

a = base redemption yield used in group index at date $_0$.
b = current " " "
b_1 = base redemption yield at date $_0$, recalculated at date $_0$ price to the maturity assumed at date $_1$.
c = notional base yield required as from date $_1$.
x = index number at date $_0$ for group in which constituents are to be changed as from date $_1$.

a, b and x are given; b_1 or c are to be found. All dates in brackets below refer to date $_0$; c first takes effect at date $_1$.

(1) 2¼ per cent. Exchequer Stock 1955 added to Group (A) (31.iii.50).

$$b = 2{\cdot}223. \qquad x = 88{\cdot}1.$$

$$\frac{c}{b} \times 100 = x. \qquad c = 1{\cdot}958.$$

(2) 3 per cent. Savings Bonds 1965–75 in Group (C); maturity changed from 1965 to 1975 (31.iii.49).

$a = 2{\cdot}819.$

$b = 2{\cdot}824$ (life 16 years 4½ months to 15.viii.65).

$b_1 = 2{\cdot}875$ (" 26 " 4½ " 15.viii.75).

$$\frac{c}{b_1} \times 100 = \frac{a}{b} \times 100. \qquad c = 2{\cdot}870.$$

(3) Adjusting factor to Group (B); 4 per cent. Consols transferred to (D) (31.iii.51).

$$x = \text{antilog}\ \frac{7{\cdot}4883}{4} = \text{antilog}\ 1{\cdot}8721.$$

$$\log\left(\frac{a}{b} \times 100\right) = 1{\cdot}8395.$$

$$\text{Required factor} = \text{antilog}\left[1{\cdot}8721 - \frac{(7{\cdot}4883 - 1{\cdot}8395)}{3}\right] = \text{antilog}\ \bar{1}{\cdot}9892.$$

(1) (2) and (4) combined, in Group (B); 3 per cent. National Defence Loan 1954–58: maturity altered from 1954 to 1958; removed from (A) and substituted for 4 per cent. Funding in (B); adjusting factor for (B) removed (28.ix.51).

$$x = \text{antilog}\ \frac{5{\cdot}6129}{3} + \bar{1}{\cdot}9892 = \text{antilog}\ 1{\cdot}8602.$$

4 per cent. Funding: $\log\left(\frac{a}{b} \times 100\right) = 1{\cdot}8519.$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3 per cent. National Defence Loan: $b = 1{\cdot}827$ (life 2 years 9½ months to 15.vii.54).

$b_1 = 2{\cdot}488$ („ 6 „ 9½ „ 15.vii.58).

$$\log b_1 = {\cdot}3959.$$

$$\log\left(\frac{c}{b_1} \times 100\right) = \log c + 2{\cdot}0000 - {\cdot}3959.$$

In x, substituting above log for 1·8519 and removing adjusting factor,

$$\frac{(\log c + 2{\cdot}0000 - {\cdot}3959) + (5{\cdot}6129 - 1{\cdot}8519)}{3} = 1{\cdot}8602.$$

$$\log c = {\cdot}2155 = \log 1{\cdot}643.$$

Bibliography

BROWN, P. J. & FORSTER, W. A. (1949), *Archer's Loan Repayment and Compound Interest Tables*, 9th ed. London: Shaw.

EDWARDS, HERBERT H. (1925), *The Principles of Compound Interest*. London: Pitman.

FINANCIAL PUBLISHING COMPANY (1939), *Comprehensive Bond Values Tables*. Boston: Financial Publishing Company; London: Routledge & Kegan Paul.

PEMBER & BOYLE (1950), *British Government Securities in the Twentieth Century*. London: for private circulation.

—— (1952), *British Government Securities in the Twentieth Century: Supplement*. London: for private circulation.

TODHUNTER, RALPH (1937), *Text-Book on Compound Interest and Annuities-certain*, 4th ed.; revised by SIMMONDS, R. C., & THOMPSON, T. P. Cambridge: published for the Institute of Actuaries at the University Press.

DISCUSSION ON MISS RIX'S PAPER

Mr. H. W. HAYCOCKS: I agree with Miss Rix that for many purposes an ordinary price index of gilt-edged securities is of little value. Purpose is all important—if one is interested in yields it is foolish to look at some figure which does not measure yields. If one is interested in capital appreciation or depreciation over a short period, then it is reasonable to use ordinary price indices.

I often wonder whether any of the index numbers of stock exchange security prices are put to any valuable use. Professor Kendall recently made a serious effort to analyse their movements, but in general they serve as little more than window dressing. I should have liked Miss Rix to discuss this side of the matter—her remark at the end of section 2, that it is legitimate to want to make generalizations about gilt-edged securities hardly justifies the publication of index numbers. It is true that economists and institutional investors are aware that they must study some indicator of dated as well as of undated stocks, but so far as I know they either select securities representative of the type they purchase or they make a general survey of yields in a way which I shall discuss later.

Assuming, however, that we want index numbers indicating the movements of values (as distinct from prices) in the gilt-edged market—how should the technical problem be solved? My feeling about Miss Rix's method is that it is too arbitrary and if only the index numbers are given, the movements are almost impossible to interpret. Let me illustrate this by reference to the index numbers for groups A and B.

If we compare the movement of groups A and B over the whole period, we find that according to the author's index numbers group B (the mediums) have lost much more in value that group A (shorts). In fact the fall in B is large relative to all groups and I find this rather puzzling. In each group A and B there is one security which has remained in the group throughout the period —2½ per cent. National War Bonds 1952–54 in A and 2½ per cent. Funding Loan 1956–61 in B. The individual index numbers for these two securities fell to 58·5 and 64·9 respectively, giving just the opposite impression to that given by Miss Rix's figures. It might be argued that this is not a fair comparison because the terms get shorter as we proceed over the period. However, this applies to both securities, so that one is still left with the feeling that shorts have fallen more than mediums (or in other words that yields have risen relatively more for shorts than for mediums).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Further, it must be remembered that the average term is not maintained constant in the author's groups. This is a variable that an ideal index should take into account.

It is interesting to examine carefully the construction of the author's index numbers in order to find out any reasons for this puzzling effect. Miss Rix's index for shorts has remained relatively high because of the introduction of 2½ per cent. National War Bonds 1954–56 and 3 per cent. National Defence Loan 1954–58 in September, 1949. At this date their yields were appreciably higher than those of the other two securities in the group, and during the period of their inclusion their movements were very different from that of the permanent member 2½ per cent. National War Bonds 1952–54. This was particularly so with 3 per cent. National Defence Loan. It is included for the period September, 1949 to September, 1951, during which period the yield fell from 2·41 to 1·83 whilst that for the permanent constituent fell only from 2·07 to 1·92. The amount of 3 per cent. National Defence is relatively small, and I understand that it is very tightly held by the banks, so that movements in the yield might easily get out of step with movements in other yields. This brings out the fact that another variable must be taken into account—marketability. It would be difficult to allow for this in an index of changing constituents.

The main point that arises from these considerations is that the date when a security is introduced can have an important effect on the level of the index number. The choice of date is arbitrary because often one is undecided whether to take the first or final date of redemption. Miss Rix gives an example of this in the case of 2½ per cent. National War Bonds 1952–54. In March, 1950, apparently some remarks by the Chancellor caused the market to revise its expectation of redemption from 1952 to 1954. This sort of thing could happen at any time, and emphasizes my contention that the choice of security and the date of entry into a group can at times be arbitrary and subject to much personal bias. It does mean that if only the index numbers are available, then only the compiler is really in a position to understand and explain the movements.

An examination of group B gives us an illustration of the other arbitrary influence—the choice of removal of a security. 2½ per cent. Funding Loan, 1956–61 remained in the group the whole period, and its index number fell to 64·9 compared with the group index of 59·3. The reason for this was the inclusion of 4 per cent. Consols, 1957 or after and 4 per cent. Funding Loan, 1960–90. The yields of both these securities, particularly that of 4 per cent. Consols, rose to relatively very high levels before they were removed, and the effect was to pull down the group index. It seems doubtful whether these two securities should be included in the group at all. The yields suggest that the market ceased to regard them as mediums before they were removed, and in any case greater homogeneity would be obtained by separating high coupon securities from low coupon securities. I also feel that the interval of group B is too wide; the compiler would always be in danger of having a heterogeneous group.

I should now like to consider an alternative method of constructing index numbers. I am afraid that I have not had time to work it out in any detail. It is well known that some brokers circulate lists showing the yields on gilt-edged securities according to term. They actually keep a continuous graph in this form, so that at any moment they can see how the market is going and which securities seem to be out of line. I am much indebted to Messrs. Pember & Boyle for allowing me to see their records. The graphs themselves give the best picture but it seems to me that they could form the basis of an index number which summarizes the graphs. All we need do is to fit a smooth curve to the yields; it will probably be found that a simple type of curve—a polynomial or the logistic—can be fitted, and then we can take the yields from the curve as a basis of the index number. The mean values over, say, each five years of term would give separate index numbers. There would be no need for any arbitrary choice of securities and the problem of chaining would not arise. It might be argued that the fitting of a curve introduces personal bias, but I think it would be possible to lay down fairly stringent rules about the type of curve and the method of fitting. Even if the graphs were drawn free-hand I do not think that there would be much scope for argument. Further, if we were uncertain about the term of a particular security, the effect of the choice on the position of the curve would probably be small. An index on this basis could be interpreted either as an index of value or an index of yield. This is not so with Miss Rix's index, because it is a chain index, and the constituents vary in a rather arbitrary manner. I would hesitate to include shorts in an over-all index on the ground that they are the stock-in-trade of a very special market, and the movements are of more significance in considering monetary policy than in considering any other problem. An examination of graphs of this type shows that the yield on shorts has risen relatively to that on mediums.

Finally, I should like to comment on the *Investors' Chronicle* yield index, which Miss Rix mentions. It seems to me a good example of what one should not do with index numbers. It is an index of index numbers—one might call it a meta-index number. This index is based on movements in the Actuaries' Ordinary Share index and the corresponding yield. It is assumed that if the proportionate movement in the price index is not equal and opposite to the proportionate

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

movement in the yield, there has been a change in dividends. But this assumption is by no means true, for three reasons: (1) there may be some companies not paying a dividend. This was the case in the Actuaries' Index during and just after the war. In this situation there can be changes in prices without any corresponding changes in average yields. (2) The price index is a geometric average whilst the yield is the arithmetic mean of the individual yields. Because of the different weighting involved it is possible for both the price index and the yield to move slightly in the same direction although dividends remain unchanged. I can give numerous examples of this from the Actuaries' Fixed Interest Indices. (3) The price index is a chain index. If at a given time securities are removed the price index at this time is left unchanged, but the average yield will change unless the average yield of the securities removed is the same as that for the whole group —a most unlikely event. Since the war a large number of securities have been removed from the Actuaries' Index.

Some years ago I worked out a true yield index of securities in the Actuaries' Index over a period of two years, and the movements were very different from those given by the index published in the *Investors' Chronicle*. I did not continue the investigation, so that I cannot say anything about the accumulated error.

I hope that Miss Rix forgives me for being so critical. She has raised an interesting technical problem and deserves our thanks for enabling us to discuss it. I have much pleasure in moving a very warm vote of thanks to her.

Professor C. F. CARTER (in seconding the vote of thanks): It is a pleasure to be able to congratulate Miss Rix on sweeping out another dusty corner in British statistics. Her paper shows care and common sense, and I am particularly glad to see her emphasis on redemption yields. Economists will certainly appreciate the new information provided on interest rates.

I hope, however, that we shall be hearing from her again. The trouble about a general index of gilt-edged values is that, being tailored to fit anyone, it fits no one exactly. Miss Rix's index numbers appear to be most relevant to the charities and pension funds which are fortunate enough to be able to fix their eyes on gross yields. It would be useful, I think, to have separate index numbers for one or two main classes of taxpaying investor. It is perhaps worth noting that the net yields used in Tables 2 and 3 assume a constant rate of tax; they produce a more variable version of the main index. But if, in addition, we take account of the fact that tax rates sometimes change, then net rates will not only be more variable than gross, they will move to different levels.

If I were an operator in the gilt-edged market, I should have an incorrigible tendency to think in terms of a particular portfolio of securities. Again, Miss Rix has recourse to the principle that, since she cannot suit everyone, she will take no notice of anyone; she therefore adopts an arbitrary weighting within a list of securities chosen to be "important". It is true that the size of an issue is not a measure of its importance in the market, but it is not therefore obvious that it can be ignored altogether within the selected group. Mr. A. G. Ellinger and I have recently done an experiment which may serve as a warning to those who make up index numbers by deliberate selection. The *Financial Times* Industrial Ordinary Share Index stood at the end of last year 15 per cent. above its 1935 base. This index is composed of leading shares, deliberately selected. We drew ten separate random samples of equity shares; these showed varying degrees of appreciation, but with a marked peak, not at 15 per cent., but at 100–110 per cent. (The actual figures, as a percentage of 1935, were: 143, 202, 204, 205, 208, 214, 233, 269, 288, 568.) In other words, the deliberate choice of market leaders ignores the greater chances of appreciation among the smaller companies. Of the ordinary share indices only Moody's is scientifically constructed with a proper balance of small and large companies.

Now I do not for one moment suggest that Miss Rix's expert knowledge, applied to the gilt-edged market, could produce a result like that quoted above. She will, I am sure, tell us that it would be very wrong to compare her index for 1965 directly with its base in 1948. But I do suggest that the dangers involved in deliberate selection and arbitrary weighting are grave enough to warrant some experiments to find out what would have happened if a different choice had been made.

One final point. I think that perhaps on balance the choice of a geometric mean for the index is justified. It is perhaps a little too brief to say that it avoids "distortion due to the selection of a particular base date"; what it does is to eliminate the effect of the base date in making comparisons *by means of a ratio* between two other dates. But, despite the usual preference for geometric means in such work, I cannot help thinking that the user thinks more naturally in terms of arithmetic means. Thus the investor interested in capital appreciation wants a plain arithmetic price index whose movements correspond to pounds of capital value; and I suspect that the investor whose eyes are fixed on redemption yields would think of the mean yield of his holding —i.e., he would think of values in terms of a reciprocal of an arithmetic mean of yields. And the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

non-investor user of such indices must beware of looking at and interpreting the market in a way which the investor would regard as irrelevant.

Though I should like to see more, there is little that I should like to see different, and I hope that Miss Rix's indices will be regularly and publicly available to all those interested in the gilt-edged market.

The vote of thanks was put to the meeting and carried unanimously.

Mr. W. F. CRICK: There are two points I should like to make about the construction of the index itself. First, it suffers from the weakness common to most indices in that it reflects the situation on a single day in each month, besides finding its base in the records for a single day. It is well known that all sorts of extraneous factors, such as unexpected political or diplomatic incidents, the illness or death of a national leader, or the anticipation of important speeches or events, may have quite substantial effects upon the prices recorded on the Stock Exchange on a particular day. This is especially true in a market which oftentimes is both narrow and sensitive —there have been many occasions, for example, in recent years when it has been impracticable to buy or sell even half-a-million of a given stock at prices within the official quotations. In such a market one quite modest transaction may have a disproportionate effect upon the recorded price. I would urge very strongly that any improved composite index should take account of these facts and be worked from averages over a number of days within the month.

Secondly, the imperfections of the raw material must be admitted. It is well understood that the prices entered in the "business done" column of the official list are not complete, are wholly unweighted, and may not be truly representative of the sum total of dealings. Even the official quotations, moreover, are arrived at, day by day, by a process in which there is a considerable margin of what might be called "tolerance". It is worth considering whether it might not be more realistic to use the closing middle prices recorded, on the basis of actual dealings, in one of the authoritative daily lists issued by leading firms of brokers.

Leaving aside the construction of the index itself, I would seriously recommend the writer to reconsider the historical remarks at the end of her paper. I doubt whether any balanced analysis of the movements since the end of the war could be compressed within so short a space. To illustrate my point, let me mention just two factors of importance in determining the course of the market which find no specific mention in these paragraphs. First, there is the fact that for perhaps five years from the end of the war industrial and trading companies were continuous sellers of gilt-edged as possibilities opened up for using reserved funds for the rehabilitation of fixed assets and the replenishment of stocks. These sales were a persistent drag upon the market over a long period. Secondly, notice needs to be taken of the tendency within more recent years for such institutions as may have held undated stocks to get rid of their holdings and re-invest in dated securities, and—as part of the same movement—the widespread institutional effort to switch towards shorter dated securities. Clearly this process, in itself, must have had some effect upon the relation between yields on long- and short-term securities.

Finally, with apologies for any appearance of quibbling, may I question the use of the phrase "officially supported"? What the writer has in mind, no doubt, is the prop under the level of prices that was for so long maintained by the continuous demand of the National Debt Commissioners, not only on behalf of the national insurance funds, but also on behalf of the savings banks. The absorption of securities in this manner, however, needs to be kept distinct from the kind of action that is perhaps more accurately to be described as "official support", namely, the appearance of the Government broker at critical moments with actual or prospective orders having an appreciable psychological effect in strengthening the basis of day-to-day prices. Such operations have been extremely rare ever since 1947. In any thorough analysis of the course of events account would need to be taken of both types of operation; meanwhile much light has been thrown on the technique of management of official funds by the evidence of the head of the National Debt Office before the Public Accounts Committee last June.

What I am pleading for here is a much more thorough and balanced historical analysis of the course of affairs than could reasonably be included in a paper which, after all, is concerned with the construction of the proposed new index and the advantages claimed for it over other available indices.

Mr. A. F. WOOTTON: I have been engaged on gilt-edged statistics for the past seven years, and during the last three have produced a gilt-edged index. Average yield fluctuations over a group of securities were related to the yield on imaginary stock of certain fixed life, the price of which constitutes the index. This was devised for those who deal in the gilt-edged market as opposed to the pure statistician or economist.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Miss RIX subsequently replied in writing as follows:

Although Mr. Haycocks's references to the use and abuse of security index numbers in general are of considerable interest, the philosophy of such index numbers and their connection with yields are wide subjects which could be only briefly discussed in my paper. Changes in gilt-edged prices are probably studied by economists mainly from the point of view of the cheapness or dearness of money, and the yield approach seems reasonable in this particular market.

I agree with Mr. Haycocks that the arbitrary choice of securities and the linking technique employed can at times have a serious distorting effect. I am grateful for his careful analysis of this problem, and admit that group (B) in particular appears in my table to have done worse than is really the case. My suggested solution would be to abandon any limit on the number of securities and to cover virtually all British Government securities. The effect of a change in group of any one stock would thereby be reduced.

While index numbers based on yields obtained from a curve fitted to redemption yields in any one class would no doubt be better than the method actually employed, we might in exceptional times still have disturbance due to the transfer of stocks from one class to another. As for the exclusion of shorts, these do not move with complete independence of other classes. Great as the objections are to combining shorts with other categories of gilt-edged, my belief is that the objections to excluding them are greater still.

Professor Carter suggests that more attention might be paid to net redemption yields, and I agree that supplementary index numbers using that type of yield would in practice be useful for particular classes of investor. It has been pointed out to me that this affects group (C) primarily though even in this group considerable importance must be attached to the operations of the non-taxpaying pension funds. In my own illustrations the 7*s.* 6*d.* tax rate used is that applicable to life offices, and has not changed in the period 1948–52. It is doubtful whether other classes of taxpaying investors influence the market materially.

I would agree now that the use of the more familiar arithmetic mean would be as acceptable as the geometric, and that the use of one type of average rather than another is less important than overcoming the distortion due to linking. As stated in my reply to Mr. Haycocks, I agree that the arbitrary choice of securities is unsatisfactory, and would propose making the index more comprehensive.

There is room for a good deal of statistical work on British security prices classified by quality rather than by industry, and Professor Carter's brief summary of the inquiry he undertook with Mr. Ellinger is most instructive. I think they would find the smaller companies are more extreme in their price movements than the leaders—downwards as well as upwards.

While Mr. Crick rightly draws attention to the sensitiveness of gilt-edged prices to the situation on a particular day, I do not think this much affects comparisons in an index at quarterly intervals, though the technique employed can of course be used for much shorter intervals. For calculations made, say, weekly or daily, I agree that prices obtained from market sources would be preferable to official quotations.

Being concerned mainly with questions of technique, my paper no doubt deals incompletely with the more general factors influencing gilt-edged prices in 1948–52. Unfortunately very little is known about industrial companies' gilt-edged holdings, which are bought as temporary alternatives to cash. The importance of industrial buying or selling is much greater than the (unknown) average size of the holdings would suggest.

Mr. Wootton's technique of working from prices to yields and then back to the price of an imaginary stock of fixed life is of much statistical interest. The choice of that fixed life does, however, introduce an arbitrary element which I have been guilty of using myself, but which is an admitted defect in my own calculations.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Edward Arnold.
Hubert Oswald Earle Barker.
George Bernard Bleazard.
Arthur Denis Denton.
Charles Daly.
Jason Hanekwu Bieronwu Enemuo.
Helen Macrae McKenzie.
George McTaggart.
Gordon James Piller.
Thayne Toon.
Samuel Weiss.
Eric Basil Willmott.

Corporate Representative

Desmond Francis Kiernan Leedon, *representing* Phillips Electrical, Ltd.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Statistical Investigations of Labour Productivity in Cotton Spinning

By L. H. C. Tippett and P. D. Vincent

[Read before the Royal Statistical Society, April 22nd, 1953,
Mr. E. C. Fieller, Vice-President, in the Chair]

Introduction

Some years ago one of us (Tippett, 1947) described briefly some so-called "abbreviated surveys" of labour productivity in cotton spinning in Lancashire, and a further description, intended specially for members of the textile industry, has since been published by the other (Vincent, 1948). Behind the investigation was the idea that the four or five hundred mills in the county were producing broadly similar products by methods that were broadly similar, but that over the years had grown up practices that differed from mill to mill in detail, and that these differences caused variations in labour productivity. It was hoped that by measuring the variations and relating them to the differences in practice, information would quickly be obtained which would assist managements in finding ways of increasing productivity, and that the study would lead to results of immediate applicability because the differences in practice were all within the general framework of practices that were traditional to the industry and immediately acceptable to many, if not most, managers and operatives, and to the employers' associations and trade unions.

The surveys were made primarily for the information of the managements of spinning mills; the results are technical and are of direct value only within the industry. They have had and are having their effect on the industry, although this is perhaps not as great as was at one time hoped. But a wider interest has been shown in the whole investigation, and so this report is presented. From the point of view of people outside the cotton industry the report is perhaps best regarded as a chapter in the history of the methods of studying industrial productivity. It would be idle, however, for us to suppose that readers will not be interested in the results, but we present them with two cautionary notes: (1) the available information is not complete and conclusions drawn from partial knowledge can only be tentative, and (2) there have been changes in many mills since 1948, when the survey was completed.

Description of Processing

An appreciation of the results is aided by some knowledge of the processing, of which we give a brief description in this section.

Cotton reaches the mill compressed into *bales*, each containing about 500 lb. It is cleaned and the fibres are loosened in sets of *opening* machines, which are in the charge of very few operatives and serve the whole mill. The material is delivered from the openers in the form of rolled-up blankets, each weighing about 40 lb., called *laps*. These laps pass to the sequence of machines in the cardroom listed in Table 1. From the cards the cotton is delivered in a rope-like form called *sliver*, several slivers are blended at the *draw frame* to make a more uniform sliver, and this is progressively attenuated into thinner products called, in turn, *slubbing*, *intermediate*, *roving*, and *yarn*. Yarn is from two hundred to four hundred times thinner than the sliver. The thinness of the product up to and including the roving is expressed as the *hank number*, and that of the yarn as the *count*, both of which are the number of hanks of 840 yards that weigh 1 lb. After the opening process the machines up to the roving stage are grouped into *preparations*, of which most mills have from four to ten, each capable of processing a different quality of cotton and making a different hank number of roving. In each preparation there are ten to twenty cards with one operative; one *draw frame*, one *slubber*, and a pair of *intermediates*, each with one operative; and finally four to six *rovers* with two or three operatives. These operatives sometimes have or share assistants, who are often learners. The operatives feed the supply cans or bobbins to the machines (the operation is termed *creeling*), remove the completed cans or bobbins (*doffing*), and mend breaks in the material (*piecing*). They also transport cans or bobbins to the next

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

stage of the preparation, and generally supervise the running of their machines, particularly keeping them free from dirt and fluff. The stages from opening to rover are all in one main department of the mill, called the *card room*. *Ring* and *mule* spinning are alternative processes for making yarn from the roving, performed in departments separate from each other (if a mill has both) and separate from the cardroom. One ring frame operative, or *spinner*, looks after two frames or so, and performs essentially the duties described for the cardroom operatives, except for doffing. That is performed by teams of *doffers*, one team serving the frames of several spinners. Mules are long machines run in pairs by a team of two or three male operatives who do the creeling, doffing, piecing, cleaning, and supervision of their pair. Most of the other operatives in the mill are women, often juvenile. In addition, there are *ancillary workers* in all departments who assist with transport, machine maintenance, and general cleaning.

Since creeling and doffing are a large part of the operatives' duties, the form in which the material is produced—the "package"—is significant. Sliver is coiled loosely into a tall can; all the other products, except mule yarn, are wound on to wooden bobbins; mule yarn is wound on to a paper tube, and called a "cop". These packages are listed in Table 1.

TABLE 1

Stages, Machines, Products and Packages, in a Cotton Spinning Preparation

Stage	*Machine*	*Product*	*Package*
Card Room			
Opening and cleaning . .	Opener Unit	Lap	Lap
Carding	Card	Sliver	Can
Drawing	Draw frame (2 or 3 in series)	,,	,,
Speed frames	Slubber	Slubbing	Bobbin
	Intermediate	Intermediate	,,
	Rover	Roving	,,
Ring Room .			
Spinning	Ring frame	Yarn	,,
Mule Room			
Spinning	Mule	,,	Cop

The foregoing is a description of the basic pattern of a cotton spinning mill, somewhat simplified; there may be substantial variations in detail. Moreover, with the coming of the so-called "shortened processing" and "redeployment" there are fundamental changes in the arrangements which would have to be taken into account in any future investigation of the industry. However, these later developments do not affect the data given in this paper, and for years to come there will be enough of the industry working on traditional lines to give the results cogency.

COLLECTION OF DATA

A list of about 100 mills was compiled, the mills being chosen as covering the main types in the industry and belonging to firms who would be likely to co-operate in the investigation, and in fact all but one cordially agreed. These mills do not constitute a random sample of the industry but are a substantial proportion of it, and to suggest that they are untypical would be perverse. When, about a year later, the Cotton Board conducted a full productivity census (see Shaw, 1950), the average results agreed well with those given by the Shirley Institute surveys.

For each mill the following data were obtained: (1) the output of yarn of various counts and qualities produced during a given period, usually of four weeks, (2) the numbers of operative-hours of various kinds employed in the different departments in the mill during that period, and (3) the numbers of machine-hours worked at the various processes. In addition, a considerable amount of technical information was obtained of the lay-out of machines, the sequence of processes and the general labour arrangements; of the machine speeds, numbers of spindles, and so on; of the principal processing particulars; and of the types of cotton used. No information about money costs was sought.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The data were recorded on standard forms, the design of which was decided after one or two pilot surveys. As we have indicated, there are many processes and types of operative in a spinning mill, and a set of forms to record the information for one mill in sufficient detail occupied fourteen sheets of foolscap. These forms were sent to the mill in advance so that the management could see what was required and, if so minded, could start the collection of the information. About a week later field workers from the Shirley Institute called at the mill to undertake the final completion of the forms. The machine-hours, operative hours, and quantities of yarn produced, were taken from routine mill records and were checked for internal consistency and accuracy. Particular care was necessary in evaluating overtime hours and the hours worked by part-time operatives. The technical and general information was supplied by managers and foremen and could not easily be checked; in fact, subsequent investigation has disclosed that at a few mills it was not completely reliable in some of the particulars that are not frequently measured in the mill routine, but we are confident that any errors of this kind have had little influence on our results. It took two field workers anything from a few days to two weeks or so to survey a mill, according to the complexity of the mill.

REDUCTION OF DATA

Most mills had more than one set of processing conditions and spun more than one count or type of yarn. Results for yarns of the same type covering a fairly narrow range of counts were pooled; those for different types and very different ranges of counts or for yarns spun under different conditions were treated separately. Such different sets of results are here regarded as coming from separate "mills" even though in fact they are from the same mill. This treatment of the data involved the exercise of discretion in deciding what degree of separation was practicable in each mill and what variations in yarns and conditions were technically important enough to require separation. Some judgment had also to be exercised in allocating the labour required for common services. For example, in the ring room a team of doffers may serve frames spinning a wide range of counts, and then the total doffing labour was allocated according to the weight of each count produced.

In the analysis, the count of the final yarn spun is treated as the main independent variable, and the various measures of productivity are plotted against this. When a range of counts is pooled, the average count weighted according to the pounds of each count produced is used. This particular average is not defensible on statistical grounds, but it is the one usually adopted in the industry and the issue is not very important.

Main interest centred on the labour productivity and, as a measure of this, the operative hours per unit of production (OHP) rather than its inverse was an obvious choice. It decreases as productivity increases, but has the supreme virtue, for an investigation of this kind, of being additive. The choice of the unit of production has proved more difficult. The most practical unit is 100 lb. of yarn, and since results have been presented to the industry in terms of this measure, OHP has come to be accepted as the operative hours per 100 lb. of yarn. For statistical analysis, however, OHP is not the ideal measure. It increases with count at almost every process but the correlation is not linear, and the degree of scatter about the regression line usually increases with count. Another natural basis of measurement is the length of yarn spun, and so we have defined

$$\text{OHY} = \frac{\text{OHP (in 100 lb.)} \times 1{,}000}{\text{count}} = \text{operative hours per 100,000 hanks of 840 yds.}$$

This measure is still not ideal for statistical analysis—the degree of scatter about the regression line on count for some processes decreases as count increases, but it seems to be better in this respect than OHP and has been used in the next section. Presumably it should be possible to find a transformation of the variables that would be ideal statistically, but such a measure would appear artificial to the technician, and we have thought it better to retain measures that have a technical meaning.

No attempt is made here to value the hours of the different grades and types of operative—any allowance that is made for such differences must be made qualitatively when interpreting the figures.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Results

The results for card rooms, ring rooms, and mule rooms, are given in Figs. 1, 2, and 3, respectively. It would be wearisome, as well as unnecessary for present purposes, to give results in full detail for each process and type of operative, so there has been some grouping. The most important independent variable is the count of yarn being spun, and OHY values are plotted against the log average count, the logarithmic transformation giving a fairly uniform distribution of points along the x-axis.

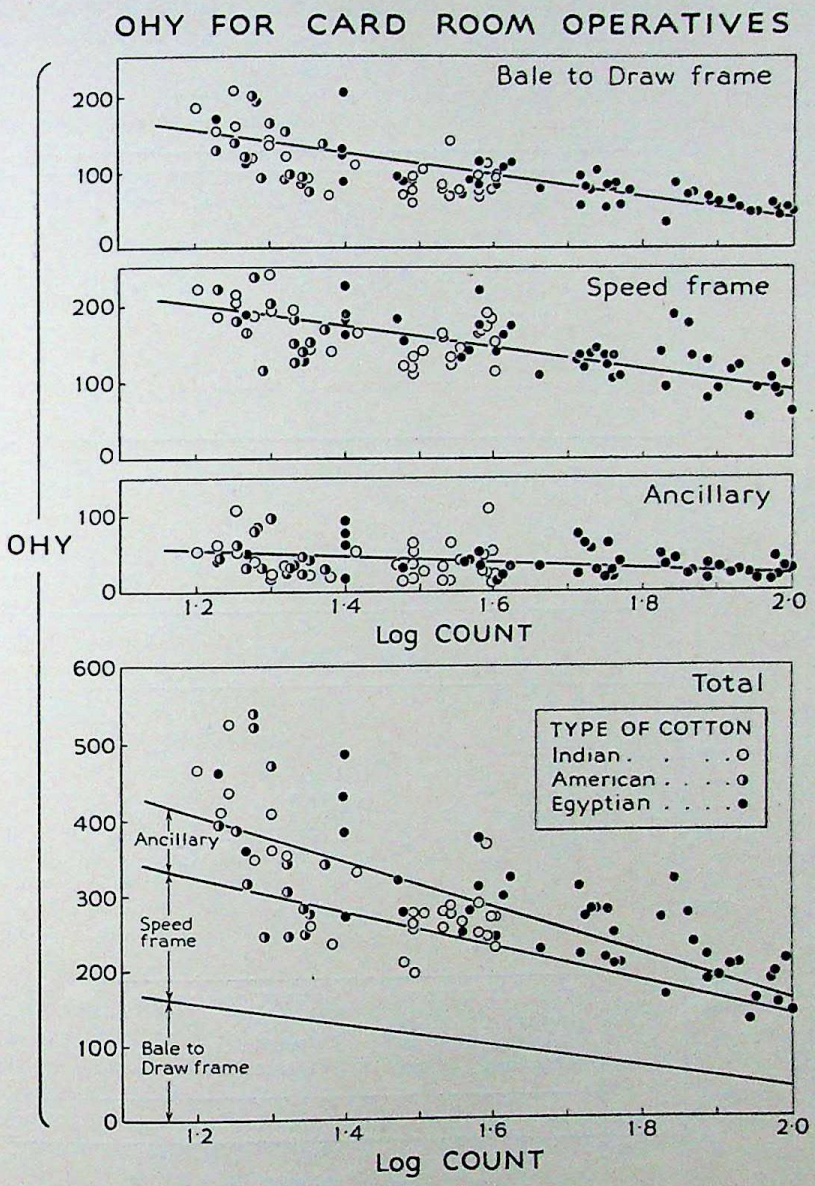


Fig. 1

There are three broad types of cotton in use, viz., Indian and short-staple American types of cotton, long-staple American types, and Egyptian types, and the type is designated in most of the charts. The types are given in order of increasing excellence of quality, as the spinner appreciates it, but there is considerable variation in quality within the types and an overlap between

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

them. The charts show a marked tendency for the Egyptian type cottons to be spun into the finer yarns and for the Indian type to be used for the coarsest yarns—a tendency that is well-known in Lancashire. But no tendency is apparent for the OHY at any one count to depend on the

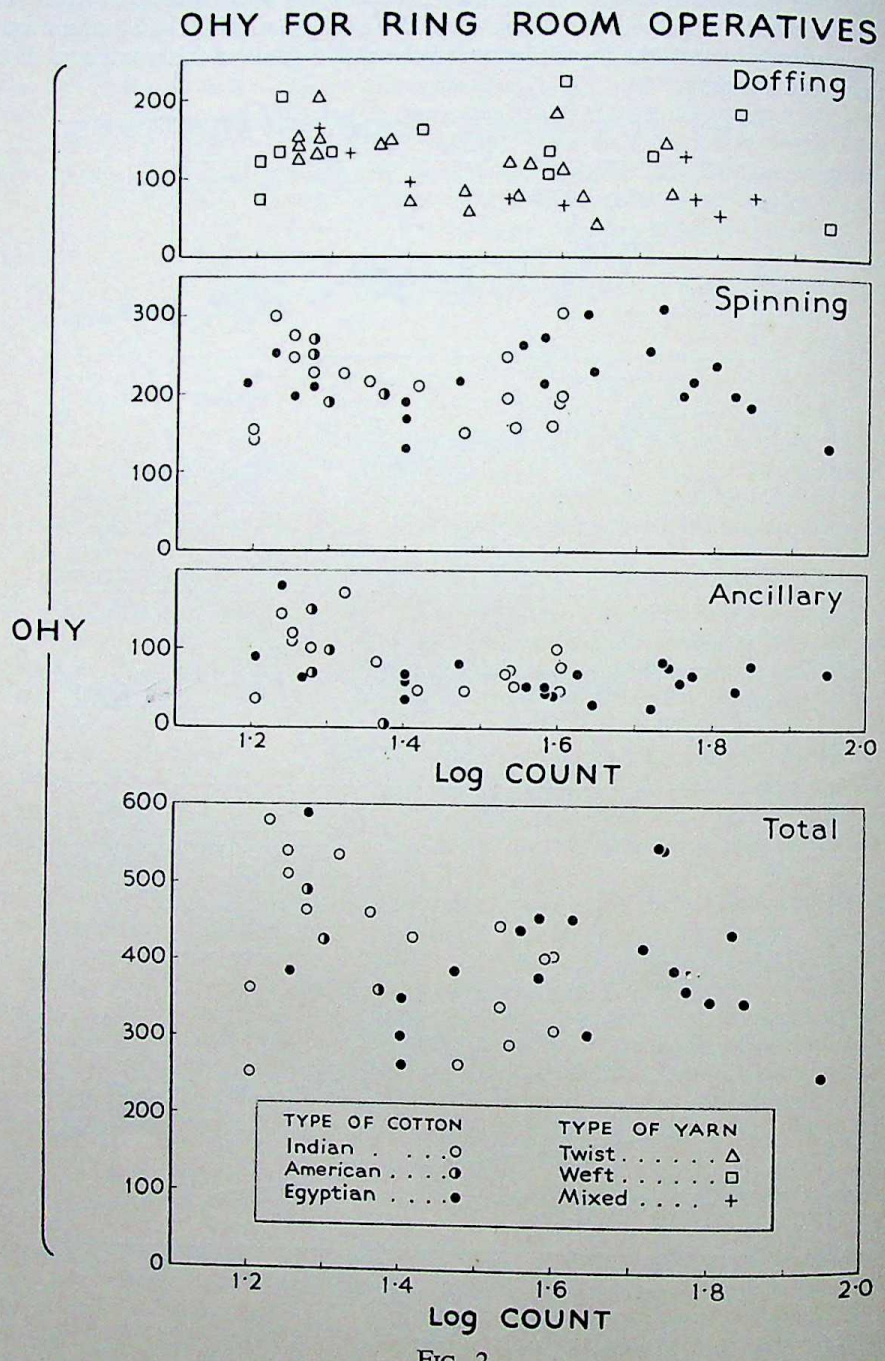


FIG. 2

type of cotton. Nor from general experience should we expect the variations in OHY to be attributable to variations in raw material to any appreciable degree, because—count for count—there is no appreciable change in the output per spindle, and with traditional methods of allocating

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the spindles to the operative no allowance is made for changes in the amount of cleaning or the frequency of piecing—the two factors most affected by the quality of the raw cotton.

In two charts of Figs. 2 and 3 a distinction is made between *twist*, that is the *warp* yarn, and *weft*. Twist generally takes longer to spin a given length, other things being equal, and is usually spun on to larger bobbins or cops, so that doffings are less frequent. The distinction between twist and weft in their effect on labour requirements and productivity is not sharp, however. Possibly, for ring doffers, weft values of OHY tend to be somewhat higher than twist values, but the tendency is not large compared with the random variations, and we make no further differentiation between twist and weft.

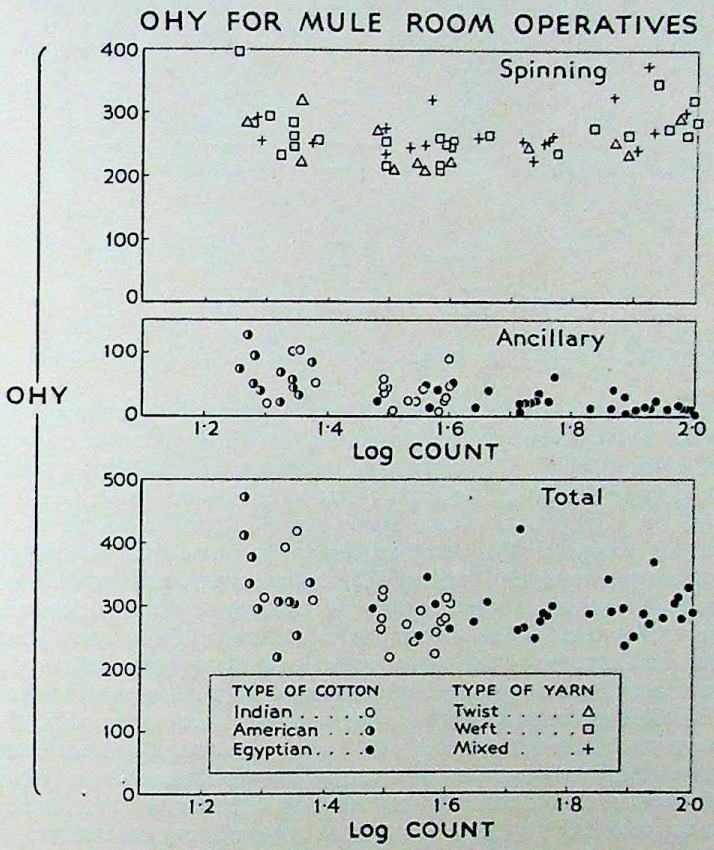


FIG. 3

Now let us examine Figs. 1, 2 and 3 from the point of view of statistical methods to be adopted in subsequent analysis. In Fig. 1 there is a distinct tendency for OHY to decrease as the count increases, and the regressions are substantially linear. The variation in OHY about the regression line also decreases as the count increases, but we have applied ordinary regression analysis as an approximation. None of our inferences depends on the various estimates being very precise, and we have not felt it necessary to make any tests of statistical significance.

In Figs. 2 and 3 the only appreciable regressions, if they are appreciable, are those for the ancillary labour; they are not strong and the ancillary labour does not make a very important contribution to the total OHY, so we have ignored these regressions. There is possibly a slight tendency for the OHY for ring spinners (Fig. 2) to fall to a minimum for log count round about 1·4, but we can see no technical reason for this and so have also ignored this effect. Altogether, we have treated the results for the ring and mule rooms on the assumption that OHY is substantially independent of the count.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 2

Process and Symbol	*Mean OHY* (1)	*Regression on log Count* (2)	*Direct Variance** (3)	*Standard Deviation** (4)	*Coefficient of Variation** (5)	*Associated Variance** (6)
Card Room (90 mills)						
Up to draw frames . (*d*)	100	−137	812	28	28	2,464
Speed frames . . (*s*)	154	−142	1,005	32	21	2,439
Ancillary . . . (*x*)	41	− 33	438	21	51	1,339
Total . . . (*C*)	295	−312	4,248	65	22	—
Ring Room (42 mills)						
Spinners . . . (*t*)	222	—	2,911	54	24	5,680
Doffers . . . (*e*)	120	—	2,088	46	38	5,179
Ancillary . . . (*y*)	80	—	1,830	43	54	4,503
Total . . . (*R*)	422	—	11,096	105	25	—
Mule Room (60 mills)						
Spinners . . . (*u*)	266	—	1,891	43	16	1,891
Ancillary . . . (*z*)	39	—	801	28	72	801
Total . . . (*M*)	305	—	2,669	52	17	—

* For the card room, a correction has been made for the effect of the regression of OHY on log count.

Figs. 1, 2, and 3, show the considerable variation in productivity between mills that has been well publicized and that gives rise to the impression that there is (or more precisely, was) room for improvement in most mills. It is convenient, however, to consider the statistical description of the results as given in Table 2. Columns (1) and (2) give the mean OHY and, for the card room, the regression on log count. These figures are of interest to people who have to do with the industry and its products. The substantially lower operative-hour requirement for mule as compared with ring spinning (305 against 422) was an unexpected result, but it is only one of several considerations that decide which system of spinning should be adopted.

The regression on log count is used in our analysis to correct for count. There is a temptation to use a regression such as those in Table 2 to correct industrial average values of OHY for changes in the industrial average count when studying changes in productivity for the industry. Shaw (1950) did this for OHP when making a pre- and post-war comparison of productivity in cotton spinning. Caution must, however, be observed. The regression coefficient presumably measures the relationship between OHY and log count for different mills, each of which has adapted itself for spinning that count; and it correctly measures the effect on the industrial average OHY of such changes in the industrial average log count as are produced by changes in the proportions of the total yarn spun in the coarse- and fine-count mills, the average count of each mill being unchanged. But in addition, any mill can, and most mills do, change slightly the average count spun from time to time without changing the labour arrangements, and such changes will leave the OHY substantially unaffected. Probably both kinds of changes occur, and the true correction factor (if such a thing exists) is somewhere between zero and the value estimated from the regression, which is a change in total OHY of about 1 per cent. for a change of one count. The margin of uncertainty is not large, but it sets one limit to the precision with which changes in productivity for the industry can be estimated.

Columns (3) to (6) of Table 2 give several measures of variability. The coefficients of variation in column (5) are all large, as such coefficients go. Mule spinning is reputedly more standardized in its labour production arrangement than the other processes, and the effect of this is shown in the lower coefficient of variation (we except from this the relatively unimportant ancillary workers in the mule room). Some people familiar with the industry may be surprised that the coefficient for mule spinners is as large as it is.

The importance of the component variations is in their effect on the total OHY for producing the yarn, and this is indicated by the variances in columns (3) and (6). Column (3) gives the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

variances in OHY, which may be thought of as giving the variance in total OHY that would occur if each component in turn operated alone. For the card and ring rooms the total variance is substantially greater than the sum of the components (4,248 compared with 2,255 and 11,096 compared with 6,829). This is because the OHY for the parts are correlated, and the correlation coefficients are given in Table 3. The variables correlated are denoted by subscripts, and the key to the subscripts is in Table 2.

TABLE 3

Correlation Coefficients

Card Room	
Up to draw frames × speed frames . .	$r_{ds} = +0{\cdot}60$
Up to draw frames × ancillary . . .	$r_{dx} = +0{\cdot}47$
Speed frames × ancillary	$r_{sx} = +0{\cdot}26$
Ring Room	
Spinners × doffers	$r_{te} = +0{\cdot}32$
Spinners × ancillary	$r_{ty} = +0{\cdot}25$
Doffers × ancillary	$r_{ey} = +0{\cdot}38$
Mule Room	
Spinners × ancillary	$r_{ux} = -0{\cdot}01$
Whole Mill	
Ring room × card room	$r_{RC} = +0{\cdot}46$
Mule room × card room	$r_{MC} = +0{\cdot}24$

These coefficients lead to another set of estimates of variance that have a reasonable technical meaning—the amount by which the total variance would be reduced if for each class of labour the variation in OHY were reduced to zero. For the class d of the card room this variance is

$$V_d + 2r_{ds}\sqrt{(V_dV_s)} + 2r_{dx}\sqrt{(V_dV_x)} = V_C - V_s - 2r_{sx}\sqrt{(V_sV_x)},$$

where V is the variance of the part of OHY denoted by the subscript. This is the direct variance for the part d plus that in d associated with s and x, and the values are tabulated in column (6) of Table 2. For the mule room the correlation coefficient r_{ux} is substantially zero, and the direct and associated variances are substantially equal—in Table 2 they have been made exactly equal. Fortunately for the simplicity of our conclusions, columns (3) and (6) tell much the same story.

The correlation coefficients of Table 3 although individually very low, are interesting in themselves; they can arise in a number of ways. One way is a tendency in Lancashire for the machinery to be staffed along fairly stereotyped lines, with so many frames per operative; since all the groups of operatives in any one department must over a fairly short period process the same quantity of material, any factor that increases or decreases the production per machine at any one stage in the department does so for all groups of operatives and so tends to produce a positive correlation in their productivities. We think that this influence is strong in the card room for the processes up to the draw frame and the speed frames, but such a positive correlation is weakened by departures from the standard staffing, due to such causes as the accident of what operatives happen to be available, the manager's idea of what operatives are necessary, or the employment of assistants and learners. In addition, any positive correlation would tend to be negatived if an increase in the number of operatives of one class decreased the number of another class. Where this is caused by the mere transfer of duties from one class to another there is little gain in overall productivity, but a judicious employment of extra ancillary operatives may so improve the productivity of the others as to improve the overall productivity. We doubt, however, if this kind of effect operates to any extent in the processes of cotton spinning as we observed them.

The correlation in OHY between spinners and doffers in the ring room calls for a different kind of explanation. The spinner is constantly in attendance on several frames and each team of doffers serves several spinners. When a frame is being doffed or waiting to be doffed, the spinner is losing production and productivity. A high rate of working by the doffers tends to reduce both these sources of loss, and in this way high spinner productivity goes with high doffer productivity. On the other hand, if the waiting of frames is to be made a minimum, the fact

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

that frames usually come ready for doffing irregularly calls for sufficient doffers for a team sometimes to be at hand waiting to doff. A sufficiency of doffers may thus cause high spinner productivity to go with low doffer productivity. In different mills both conditions obtain, and so a tendency to a low correlation coefficient is to be expected. We are surprised that r_{te} is as high as $+ 0{\cdot}32$.

A positive correlation coefficient in OHY between any or all the groups might be produced by variations from mill to mill in that nebulous complex we may term the quality of management. This, if it is an explanation, is the only plausible explanation we can think of for the correlation coefficients for the ring room, and also for the coefficients, which are low, between the card room and the ring and mule rooms respectively.

The correlation coefficients do not shed much light on the interactions between the groups of operatives, and conclusions depend mostly on technical knowledge of the industry, and on opinion. The chief practical conclusion from Table 3 is perhaps that the coefficients are all low enough to justify, as a first step at least, the easy course of paying attention to each group of operatives and each corresponding stage of the processing as though it was independent of the others.

Economists often ask what effect the size of the firm has on productivity. Remembering that a firm may comprise anything from one to about fifty mills, we would not attempt to give a statistical reply to this for cotton spinning. The combines vary not only in size, but also in the more important factor of the management structure and the degree of decentralization, and a simple correlation of productivity with size would be too superficial an analysis to have value. We have, however, examined the relation between OHY for various departments of the mill and the size of the mill as defined by the number of spinning spindles, weighting a ring spindle as $1\frac{1}{2}$ times a mule spindle, because the average rate of production of a ring spindle bears this ratio to that of a mule spindle. There is a correlation between yarn count on the one hand and OHY and size of mill on the other. Accordingly we have divided the results into three groups, each group covering a relatively narrow range of counts, and for each have formed a scatter diagram of OHY plotted against size. For none of these diagrams is there any evidence of a relationship of any kind. Thus we conclude that factors associated with the size of the mill are of negligible importance as causes of the variations in OHY between mills.

APPLICATION OF RESULTS

The surveys dealt with in this paper have shown the variation in productivity that existed in the spinning section of the cotton industry in 1946–8, and have put managements into the way of knowing in what mills and processes investigation and action are required.

Charts like those in Figs. 1, 2, and 3, but showing OHP instead of OHY, have been made for all categories of labour and stages in the processing, and have been made available to the industry. With the aid of these, managements can see in detail how their mills stand in relation to the rest and at what points investigation and action are called for. In presenting these charts, the regression lines were replaced by lines drawn so that about 10 per cent. of the points are below them, that is lines representing roughly the average performance of the best one-quarter mills. It was felt that whatever line was given would be regarded by the mangement as an objective, and the average performance of the industry was not regarded as a good enough one, whilst a line constituting the lower boundary of the points might be regarded as setting an unrealistic one. Since the choice of line was arbitrary, it was thought unnecessary to determine the lines precisely—they were inserted "by hand and eye". We believe that the issue of these charts and any action that follows are one of the main values of the whole investigation to the industry. Our experience has certainly established the practical usefulness and validity of the measures used—the OHP or one of its variants.

Of the causes of the variation in productivity the investigation has given little direct information. Attempts to analyse these causes were made by considering the detailed data for several pairs of mills, dealing separately with the mule room, ring room, and card room. The two mills in each pair produced yarns of similar counts or rovings of similar hank numbers, but one had an extremely high OHP and the other an extremely low OHP.

The main items that emerged were: differences in the allocation of operatives who, on paper at any rate, were working similar machines in a similar way; differences in machine output per

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

unit time for no obvious technical reason—sometimes due to differences in running speeds, sometimes due to differences in machine running efficiency; differences in package size—so that when handling the same number of bobbins per hour an operative would produce more at one mill than another; differences in the amount of assistance given to the operatives in the way of carrying and cleaning by trainees or "spare hands"; differences in operatives' age and skill; and, perhaps, differences in the balancing of outputs between consecutive stages in the processing. Attempts to provide an idea of the relative importance of these various causes were not very successful, and hardly any two pairs of mills had common causes of difference. Thus, no clear general picture emerged, and it became evident that much close investigation at each mill would be necessary to disentangle the complex of inter-acting causes and composite effects. For example, a low operative and machine productivity will usually be associated, but how far the one causes the other cannot be determined from the data collected in the survey. However, we have been able to give managements much detailed information to help them in conducting investigations and making improvements at their mill. The next paragraphs describe this information.

The first and most obvious requirement for high labour productivity is a low amount of work to process a unit quantity of yarn, and for cotton spinning this involves reducing to a minimum the numbers of creelings, doffings, and piecings, at each process by making the package sizes as large as practicable and eliminating causes of end breaks. Ultimately it is for technical research to determine how low these numbers can be under various conditions, and how to keep them low. But such research has a long way to go, and in the meantime empirical "target" values for package sizes have been derived from the results of the surveys, the values being about the highest commonly observed under ordinary conditions. In these surveys we did not observe breakage rates, but other, scantier, data have given reasonably good "target" values for these.

The second requirement for high productivity is that the operatives must do enough work, and, for this, the rate of production of the machines and the number of machines per operative must be arranged so that the operative has a full work opportunity. From the point of view of labour productivity it may not much matter whether, for example, an operative looks after two machines, each running at 40 per cent. efficiency, or one machine running at 80 per cent., but from an overall point of view it is obviously very important to arrange for the second condition. Therefore, when the work content of a unit quantity of yarn has been minimized, the next step is for management to set their machinery to work at the maximum practical speed and efficiency. There is the complication, already mentioned, that the machines in successive stages must be kept in balance, so that none is waiting for material from the previous stage or over-running the next one, and, in addition, care must be taken that the rate of production is not so high that the end-breakage rate is too great. From the surveys we know what spindle speeds, "twist multipliers", hank numbers (the technical factors that control the machine rate of production), and machine efficiencies, are obtaining in the industry. Managements can use this information to help them in choosing reasonable values for adoption in their mills. The choice of values to give a high rate of production and correct balance is a somewhat complex procedure, but it can be facilitated by following a systematic scheme that has been developed for the purpose. Having decided on machine particulars, it is then necessary to allocate the number of machines to each operative that provides a full work opportunity, and to achieve this some measure of the work done by the operatives, in terms of creeling, doffing, and piecing, is a better guide than the overall productivity figures given by OHP or OHY. It is the province of time study to make such measurements, and this is usually gone by giving the operations a time value and deriving the number of "standard minutes" a "standard" operative would require to perform the operations a given operative performs in, say, an hour. In most parts of textile processing the time basis of measurement is adequate since most of the operations require relatively little "brute force". Some time-study engineers would claim not only to measure performance, but also to have criteria of satisfactory performance. Some spinning mills have now adopted methods based on time study, and an increasing number are adopting them, but it will be a long time before such methods are universally adopted and standardized. Consequently, we have developed an alternative simplified approach based upon the development of "work indexes" (described in the Appendix) that measure in an approximate way the work done by textile operatives when working according to conventional Lancashire practice. This practice is fairly well standardized qualitatively and "job specification" of the duties to be performed is implied.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Opinions in the industry differ as to the usefulness, and even the validity, of these indexes, some people arguing that sound action cannot be based on anything less than full work study. Certainly if drastic action is taken automatically from the indications of the various measures, trouble is likely to ensue. Most statistical measures are approximate and contain only part of the relevant information, and the information excluded has to be taken into account when interpreting them. But they are useful if they include enough information and if the modifications required in interpretation are usually small. The relatively crude overall measure of productivity such as PMH (production per man-hour) or OHP have proved to be useful tools of management, in spite of their limitations: the work indexes come closer to technical realities, and we believe that they will prove to be correspondingly more useful. They are not, of course, intended to be complete substitutes for the results of work studies, but to provide approximate short-cut means of assessment in the absence of work studies.

The "target" values of the work indexes have been, and are being, derived by a mixture of empirical and analytical methods, the former based on surveys of what values are being achieved in the "best" mills, and the latter on time evaluations. The setting of "target" values requires judgment rather than refinement in statistical method. The value should be high enough to call for an improvement in most mills, and not so high as to be achievable only exceptionally. Ultimately, a decision as to what may reasonably be expected of operatives is not in the province of statisticians or textile technologists, but until the competent authorities have taken a decision, tentative values may be suggested in order that progress can be made. The values of the present work indexes are not claimed to be absolute, and managers are advised to be specially careful to take account of local conditions in aiming at them.

A final example of the use of the technique described in this paper and of the results is the comparison between the productivity in English and American spinning mills made by the spinning Productivity Team during their visit to America sponsored by the Anglo-American Council on Productivity. Values of the American OHP and the corresponding values of the English OHP, obtained from our surveys, are given for each process in the spinning mill in the report by this team to the Anglo-American Council on Productivity (1950).

APPENDIX

The Development of Special Work Indexes for Textile Operatives

OHP does not take into account the presence of differences in package weight, end-breakage rate, or cleaning and patrolling the machinery. Accordingly we have developed indexes to allow for each of these according to the contribution they make to the "work load".

Expressing the new indexes in general terms, they can be written according to the formula:

$$\begin{aligned}\text{Work index} = {} & \text{number of creelings} \\ & + k_1 \times \text{number of bobbins doffed} \\ & + k_2 \times \text{number of sliver, roving or yarn breaks} \\ & + k_3 \times \text{number of spindles,}\end{aligned}$$

all the numbers being per operative per hour except for the spindles, which are per operative. In effect the work index is a measure of time, the time taken to perform a creeling being taken as the unit of time, and in terms of this k_1 and k_2 are the times to doff a bobbin and mend a break, and k_3 is the time allowed per spindle for patrolling, cleaning, and other miscellaneous, duties.

The quantitative basis for the work indexes differs according to the process. The values of the k's differ, and also the numbers of terms included. Doffers only handle completed packages, so there is only one term for them. Ring spinners do not doff, so there is no term with k_1 for them. At the earlier processes, creeling and doffing are of such predominating importance that we use only the first two terms. For intermediate processes we use the first three terms. In order to bring the formulae into a general scheme and allow for future changes, we adopt as the full title "three-element work index, intermediate frame", and so on, according to the number of terms included.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The ratios k_1 and k_2 have been measured for a number of processes and mills, and we have derived standard values that we believe are widely applicable with a sufficient degree of accuracy for our purposes. Likewise we believe that we can specify standard values of k_3 that are reliable enough to be useful. It will be noticed that the k ratios are determined from time studies and not from statistical correlations. In presenting our target values for the card room to the industry, we have in fact kept k_1 and k_2 constant (for each process) and at the rover (when k_3 first occurs) varied k_3 in two steps, somewhat arbitrarily chosen, to provide for medium and fine quality yarns respectively.

One advantage of the work indexes as measures of performance lies in the ease with which the numbers of the operations can be determined in any mill. The number of breaks is the most difficult to determine because of their random occurrence, but even for this it is only a question of an unskilled observer observing the process for long enough.

References

SHAW, D. C. (1950), "Productivity in the cotton spinning industry", *Manchester School*, **13**, 14.
TIPPETT, L. H. C. (1947), "The study of industrial efficiency with special reference to the cotton industry", *J. R. Statist. Soc.*, **110**, 108.
VINCENT, P. D. (1948), "Variations in productivity between cotton spinning mills", *J. Text. Inst.*, **39**, 407.
Anglo-American Council on Productivity (1950), *Cotton Spinning*.

DISCUSSION ON THE PAPER BY MR. TIPPETT AND MR. VINCENT

Mr. C. T. SAUNDERS: Many Fellows of the Society must have been fascinated by this Paper and by the highly artistic exhibits (which we have missed today) shown at the Manchester Conference last August. We are glad to have this further opportunity for discussion and to know that the Paper will be preserved in a more permanent form.

In spite of the strictures and criticisms which it has suffered over the past 25 years, the cotton industry has been always in certain respects in the statistical vanguard. Unfortunately, it is probably true that there is no close correlation between statistics and prosperity (healthy people do not continually take their temperatures). The Shirley Institute's work on productivity has been familiar since the 'thirties, and it is this enforced consciousness of the improvements that could be got in productivity that brought about the Platt Productivity Mission to the United States in 1944—the prototype of productivity missions.

All this is not because productivity in the British cotton industry, relatively to that of other countries, is particularly low. In fact, Dr. Rostas's work in 1943 showed that the relation between productivity in the cotton industry in this country and that in other countries was about average, and that some industries which were generally considered to be more modern showed up worse. It is certainly time to see studies like those in the present paper for other industries which may be more discreet but are no less capable of improvement.

The feature brought out so prominently by this and other Shirley studies is the variability in productivity between mills. It is generally supposed that mill practices are uniform and mill plant standardized, and that is largely true. But I hope the authors will be able to go further and explain the variations they have found. Obviously, the need for an explanation of the variability exercises the authors' minds, and one wonders why it is still impossible to separate out some of the differences into broad categories. Is it not possible to work towards a separation of these factors into (1) those for which the customer is primarily responsible, demanding a special quality of yarn which perhaps requires a special form of package; (2) those which depend on certain physical factors, such as the lay-out of the plant or variations in raw material; (3) those associated with special differences in staffing arrangements, and (4) those differences in quality of operatives or management, which although they cannot be directly measurable, must be regarded as accounting for residual differences?

Another approach is to inquire how far the pattern of inter-mill variations remains constant over time. At any particular time many mills will be affected by special troubles, such as customers insisting on something awkward to produce, or a batch of orders which leads to an unbalanced allocation of output. There must be quite enough factors of that kind to give a fairly large variability at any one point of time.

Some of these random variability factors are obviously ironed out by taking the surveys over four weeks, but presumably not all. On this method of approach there are two possible alternatives. In the first place, is there any way of calculating theoretically from known data the kind

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of distribution of OHY that might arise from random factors, and comparing it with the actual distribution at one point of time? In the second place, is it possible to analyse the ranking of the mills in two or more of these surveys, to see which mills are, so to speak, "recidivist", and which are "first offenders" in terms of low productivity?

This Paper ought to provide some guide to the practical technique of productivity measurement which should be invaluable to people working in other industries. The fundamental problem evidently is to isolate the variables in the nature of the product. The authors allow only for three important variables: the count of yarn being the major variable, with the end-use—twist or weft—and the spinning process—mule or ring—as secondary variables. In commercial practice there are many more variables in yarn descriptions and in yarn prices. How far are the commercial people willing to accept the validity of comparisons in terms of such a small number of variables?

The really striking result in Table 2 to which the authors call attention is the greater productivity in the more old-fashioned mule spinning compared with ring spinning, in spite of the fact that the mule-spinning frame is spinning only half the time while the ring spindle is working continuously. Is this because the mule spinners get a better quality of cotton, count for count?

Finally, one must call attention to the need not only for the development of studies like these mill surveys, but also for assimilation between this kind of study and the cruder statistics of productivity based on general indexes of output and employment. The mill surveys reveal a vast amount about conditions at one point of time. The cruder statistics tell one less, but at least measure changes over time. Is there any way of developing measures of changes in something really worth knowing about? An obvious compromise is the productivity studies of the Bureau of Labor Statistics in the United States, which aim at measuring changes over time in the man-hours required to produce a standardized product. That method gives many of the advantages of both kinds of approach.

I have much pleasure in moving a vote of thanks to Mr. Tippett and Mr. Vincent.

Dr. EASTERFIELD (in seconding the vote of thanks): A number of points I had wished to make have already been raised by Mr. Saunders and I shall try only to elaborate some of them. First, I think the authors have been far too modest. They say that the work is almost entirely technical, but it is of much wider interest than that. It is an outstanding contribution to the methodology of an industry in which they found one or two factors in the final product to have an overriding effect on productivity and therefore took the trouble to compare the widely divergent end-products right across the industry.

Secondly, they have made a real effort to put the information into a form which the managements can use. I wonder if at some time they would say whether they had any success in getting managements, particularly more backward ones, interested in understanding the material they put out. Our fact-finding has put managements into two classes—those who are interested in information but can usually get all they want from other sources, and those who are not interested, so that if you hand them information it is almost impossible, short of close personal contact, to get them to do anything about it.

Again, the authors are too modest in suggesting that their working indices are to be looked upon as the next best thing to work study. If by "work study" is meant a full-scale investigation of how a job is done and how on reorganization it might be better done, they are probably right. On the other hand, a good deal of what is called work study consists of getting a standard time for a job done in the usual way by stop-watch and rating methods, the validity of which, outside the limits of use in a single firm, has been shown to be very questionable.

To return to some of the points raised by Mr. Saunders, it is most valuable to be able to study the changes of productivity with time. I have been told that there is a tendency for the average count in the mills to vary between one mill and another, not at random, but according to the pattern of demand from year to year. That being so, there may be a tendency, at any one time, for mills to be unbalanced in the same direction. The authors make the assumption that the figures collected give the picture of OHY for current production correctly. Is it not likely that at any one time they will be getting OHY for mills which are largely biased in the same direction?

Secondly, how much difference does this lack of balance make? The sort of changes which D. C. Shaw showed between individual mills brought out a very wide variation from one mill to another, and comparatively big variations between pre-war and post-war productivity. If one assumed that the correction factor for change of count was zero, how much difference would it make to results like those of Shaw?

Repeated studies at the same factories might throw light on another point. Measurements at the U.S. Bureau of Labour Statistics have shown that if firms are arranged in order of decreasing productivity relative to that of a base year their order changes strongly from year to year, as the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

productivity of many of the firms oscillates about the average. Looking at Shaw's figures, exactly the same sort of thing must have occurred. Moreover, the United States figures are, in general, not for a period of a week or even four weeks, but for a whole year. It would be interesting to find out how far such oscillation is going on over short periods and over long ones, and still more interesting to find out the causes, such as whether the pattern of demand favours one firm in one year and another in another, or whether a firm tends to pull up its efficiency, then to get slack and to pull up again.

To explain the wide range of productivity observed, some of our transatlantic friends might say that the competition in this country is not fierce enough; in the States, however, there are very wide ranges of productivity. It would be most valuable to find out the causes for this, and how far in fact any low productivity was accounted for by extraneous circumstances.

I hope that if the authors cannot answer any of these questions themselves they will pass them on to those whose business it is to do so.

The vote of thanks was put to the meeting and carried unanimously.

Mr. G. H. JOLLY: I have come to this meeting from Manchester, where I am employed as Special Officer by the Federation of Master Cotton Spinners' Associations Ltd. I have spent all my working life in the Cotton Spinning Industry, and am not a statistician. You may therefore expect me to be somewhat suspicious of the contents of the paper which has just been read, but on the contrary I should like to compliment the authors on the development of the standard methods used in their surveys and on their concept of OHP. If these methods had not been developed, and if the survey results had not been available, the Report made by the Cotton Spinning Productivity Team on its return from the U.S.A. would have been more difficult to prepare and less valuable to read. The authors are, no doubt, aware that a concept similar to OHP was subsequently adopted by the French Cotton Spinning Productivity Team.

I feel that tribute is also due to Members of the Federation in Lancashire who agreed so willingly to have surveys made by the Shirley Institute staff in their mills. This is a fine example of the co-operation which exists in these post-war years.

The results of OHP surveys may be used to compare the productivity at individual mills with that in the rest of the industry, or to measure progress. But OHP figures by themselves give no guidance as to the ways in which productivity may be increased. A high OHP (denoting low productivity) may be due to (1) technical conditions which cause the operative a large amount of work per unit of output, or (2) an unreasonably small amount of work being performed by the operative.

Work indexes may be used as a guide in defining the cause of high OHP in a particular department. If the operative's work index is already near the target, it is unlikely that OHP can be reduced unless technical conditions are improved to give the operative less work per unit of output. If the work index is significantly below the target, it is likely that the operatives have insufficient work opportunity or are exerting less than a reasonable amount of effort. Shortly after the details of the "work index" approach were made available to Members of the Shirley Institute, the Federation of Master Cotton Spinners' Associations circulated to all its Members a questionnaire form which was designed to assist them in comparing their work indexes with the target values, and in making certain other comparisons with a view to effecting improvements.

In our industry, actual rearrangements of staffing and the introduction of new methods of payment based on the actual work performed are preceded by careful work studies in each department, and I still believe this to be the best available method. If work indexes were used indiscriminately for this purpose there would be the same danger of subsequent inequities as with the transfer of average element times from one mill to another, unless great care were taken to ensure their applicability. The use of work study methods by our Members is steadily extending, and such methods are now in operation in over one-third of the mills in membership with the Federation. I consider that there is a use for both target indexes and full work studies: the former may indicate the path to be followed and speed up survey work, whilst the use of the latter ensures correct staffing of the machines and the calculation of equitable piece rates.

I should like to leave with you this final thought. It seems to me that when discussing productivity we must not forget cost, which—together with quality—has such a powerful effect on our competitive ability. In most cases higher labour productivity leads to lower costs, but there can be cases (e.g., where an extremely expensive machine must be run at maximum efficiency) where total costs are only minimized at the expense of some reduction in labour productivity, the operatives being deliberately under-loaded to a certain extent in order to keep up the machine efficiency and reduce the overhead cost per unit of output. It is interesting to remember that our friends in the U.S.A. still think it advisable to charge a duty on textiles imported from abroad.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

We are working strenuously to increase our productivity in cotton spinning, and we now have examples of departments which are well up to U.S. standards in this respect. Although a great deal has been done in the post-war years, we know that much work lies ahead, and I consider that the methods described in the paper which has just been read are important aids in our constant efforts to increase productivity, improve earnings, and reduce costs.

Mr. RYAN: It is a quarter of a century since I last spoke on cotton in this Society, and it is interesting to compare the position then with that now disclosed. I am interested to hear what has been said about the awareness of the industry concerning the problems which face it. The authors have observed some steady progress, but I wonder whether they are unduly fortunate in the date at which they conducted their investigations. It may be that in that year the industry was working under more comfortable conditions than those obtaining before or since. There might be in other years greater variations than they found in 1946. The mills will have been working to the top level of the capacity of their plant, and after such achievement will be getting lower productivity for some time, which will be compensated for to some extent because they are working to a cost factor created by keener competition.

I have very vivid recollections of an experiment we conducted on a high grade product. We made a work study of a particular job and drove the productivity upwards very successfully, but unfortunately were left with an article which we could not sell at a profit. The work had been done in such a way and at such a pace that the operatives had left dirty marks on the product, and we had to drop our productivity in order to persuade our operatives to keep their fingers clean. That is an example of factors which may act against the drive for productivity.

I think the next step, which has already been mentioned, is to encourage individual mill managers and others to sort themselves out among the people who are interested and to make case studies or individual studies of the output of the men. Some of the variables which speakers have mentioned and which detract from any kind of overall productivity will not disclose these individual factors. I think this work stimulates all concerned, at many levels, to take the next step, and I hope that real results will emerge because this will be the most useful recompense which the authors could get for their work.

Dr. ROSTAS : I should like to join in the congratulations to the authors on the presentation of their paper. I find it difficult to be critical of Mr. Tippett's work on the problem of the cotton industry, but, like other speakers, I would wish to ask for more. I agree that the authors greatly underestimate the significance of their studies. Indeed, there is a very substantial interest in this technique, and it is a great pity that there is no single comprehensive summary of the results. This paper is a welcome contribution, but I very much hope that one day it will be the basis of something much more comprehensive. I also hope that somehow the economic aspect—the cost aspect—can be brought into their research, because that would greatly enlarge the practical value of what has been placed before us. I hope that some effort will be made in that direction.

One particular problem occurred to me in this connection. The authors gave the detailed data on actual variations in the operations of a cotton mill, but no figure is given for the case of a ring mill as a whole. I wonder whether it is possible for them to provide that, for it might be quite important. One would like to know whether a low productivity obtains in all the different parts of the press or whether there are compensating factors. It would be also extremely useful if this inquiry could be repeated at some future date so that we could have accurate information for a comparison over time.

The authors subsequently replied in writing as follows:

Mr. Saunders asks us to explain more fully the differences between mills in productivity. We have dealt with this to the best of our ability in the paper, and have listed the main items. We found, however, that it was impossible to express the degree to which each item influenced the picture as a whole, and that the only satisfying explanation of why any two mills differ requires a complex and detailed investigation of each mill. To carry this out for many pairs of mills and to collate the results is a stupendous task, and would still leave out the effects of such human factors as the "quality of management". Mr. Saunders asks whether the variables in the nature of the product we have allowed for are sufficient. The answer is: Yes, as a first approximation. For investigating fine differences in productivity it might be necessary to allow for other factors, but it would be unrealistic to devote resources to these before dealing with the large differences we have found. We can only speculate on the reasons for the lower productivity in ring spinning as compared with mule spinning. On the one hand, there is a diminishing supply of mule spinners, who are male, and there has been a tendency for the staffing of mules to be reduced to a minimum, with which is accompanied the payment of "absentee" money; that is, a form of self re-deployment

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

has taken place under economic forces. On the other hand, there is less shortage of ring spinners, who are female, and the wage structure in ring spinning provides little incentive for the best labour arrangements to be sought. The Oldham wage list for ring spinners, which held until 1947, did not differentiate between different counts above 43*s*. The general impression among spinners is that, if anything, better cotton is required for ring spinning.

Dr. Easterfield raises a number of interesting and cogent questions, some of which we have already covered in our reply to Mr. Saunders. One of the main outstanding points is that of variation with time. We are now conducting a new survey over many of the same mills as before, and we are looking forward to some interesting results. Mr. Ryan wonders whether the years of our survey were favourable to uniformity of productivity. Our view is quite to the contrary. The years 1946–8 were years when mills were re-establishing themselves after having been closed during war-time "concentration," re-equipment with new machinery was getting under way, new operatives were being recruited and trained, especially European voluntary workers. These were conditions that made for high variability. Mr. Ryan also gives a good illustration of that imponderable, the human factor. Dr. Rostas asks for more detail. We carefully selected the detail given in the belief that it would serve all needs except those of the technical people in the cotton spinning industry. For these, one of us (P. D. V.) has given fairly full technical details of the method, including a copy of the questionnaire, to an O.E.E.C. committee on productivity, and we presume that these are available to all workers in the field. We shall be glad, however, to pursue this question privately with any inquirer. We deal in the paper with the correlation between the ring room and the card room.

Finally, we should like to endorse Mr. Jolly's remarks about the co-operation we have received from the members of his Federation, and particularly from the officers of the Federation itself. This has helped our task considerably. Again, we express out thanks for the kind reception given to our paper.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

David Gwilym Colin Gronow.
Hugh John McNab Jones.
Phyllis Katharine Loraine.
Ian McDonald.
Abdus Salam.
Marjorie Simpson.
Charles Stanley Smith.
Alan Kingston Soper.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Treatment of Errors

By Dudley Seers

A recent number of the Society's *Journal* (Part IV, 1952), contained an interesting paper by Mr. Roy on the problem of how to assess and show error margins in derived statistics. This is certainly a subject on which discussion is long overdue, and a debate which leads to a wider appreciation of this problem and to some agreement on how it may best be solved, would be most useful.

Mr. Roy's own solution seems, however, rather inflexible. "The least," he concludes, "that *all* economic statisticians can do is to give upper and lower limits *to every estimate published*." (My italics.) This is rather a tall order. It would mean assessing the error margin for each item in the original data, and then showing the cumulative error margin in the summary statistics on certain assumptions about their possible association. Even those who collect and process the raw material might hesitate to put a figure to the error margins of various items: private research workers must make what are only personal guesses, and the guess of one person might be ten times as high as that of another. In fact, if official statisticians do not put a margin on estimates, private research workers may well hesitate to try their hand. Showing the cumulative effect of these errors is an even more hazardous task, because the final result will be rather sensitive to the assumption one makes about the ways in which the errors may be associated. Moreover, if the construction of the summary statistics is at all complicated, as it is for most index numbers, the process of cumulation will be a very laborious one. To carry out this advice would slow down research almost to a standstill.

The best evidence of the impracticality of this rule seems to be the example Mr. Roy gave of how error margins might be estimated. Perhaps I am in a suitable position to judge this example, because as the material for his exercise, Mr. Roy took some index numbers I had calculated for changes in the "cost of living" of sections of the population which are not "working-class", sections which are often (illogically) described as the "middle classes". The principle on which this index was constructed was that a price index for all consumers must be the weighted average of the price indexes for the "working classes" and the "middle classes" so defined. Algebraically, one has to "unscramble" the weighted average and solve the equation,

$$I = e_w\, i_w + (1 - e_w) i_m,$$

where I, i_w and i_m are (Taspeyres) price indexes for the goods bought (in the base year) by the whole nation, the working classes and the middle classes respectively, and e_w is the share of working-class expenditure in total expenditure (in the base year). Thus for 1947, if 1938 is the base year,

$$173 = (\cdot 55)\ (161) + (\cdot 45) i_m,$$

which yields an answer for i_m of 187.

Mr. Roy first examines possible sources of error in the consumer price index, 173, by estimating error margins for each of the official estimates of personal consumption. By error margins he means the ranges within which he thinks there is a probability of 95 per cent. that the true figure lies. His source of these margins is "slight unofficial experience in the estimation of consumers' expenditure and some consultation of the published estimates of error". There is clearly a large subjective element in such margins. Would many other statisticians hold that awkward items such as "other goods" and "other services" might have been *over*-estimated by the Central Statistical Office to the extent of 35 per cent.? The general tendency has been to raise these estimates as more information comes to hand. These "guesses", as he calls them, and the assumption that errors are normally distributed, imply an error margin of $\pm 1 \cdot 6$ in the total consumers'

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

price index, in his sense of error margin. Making similar assumptions about errors in the weights of i_w and in the estimate of e_w, he concludes that the error margins for the middle-class index (with 95 per cent. probability) are $\pm 4{\cdot}4$.* Mr. Roy then adopted an alternative approach, dropping the assumption that errors are normally distributed. In this part of his paper he assumed that the true results are certain to be inside his error margins, and calculated what the error in the final index would be if the errors for each weight (in both national and working-class index numbers) were such that in combination they produced the maximum possible error in the final index.

The logical basis of both these approaches seems rather doubtful, and for fundamentally the same reason: we cannot be sure of the statement we make about the error margin. In the former approach the marksmanship of (e.g.) the official estimators on each item is assessed (by saying that the chance is 95 per cent. . . .). The estimate of the combined error then depends on the tacit, but crucial, assumption that we have been correct in each of our statements about the marksmanship. In brief, the probability statement (about the combined error) is made without one knowing the probability that each of the statements from which it is derived are correct. The latter method is more dogmatic, for those using it assert that at some point they know for certain that they have laid down limits outside which the true figure cannot fall. Yet the whole answer will depend on what error margins are considered beyond doubt. If we really want to be certain we must choose a margin too wide to be of much interest as a statement about the practical limits of error.

Secondly, the technique of combining errors seems open to question in each method. The former involves the "comforting assumption" that errors are not associated. Actually, the data on income, production, family expenditure, etc., in the hands of the Central Statistical Office, must rule out various combinations of errors in estimating items of personal consumption, even though the errors are individually plausible. Moreover, the estimates of some items of consumer expenditure in 1938 were doubtless derived in part from the same source as the estimates of working-class expenditure (i.e., the Ministry of Labour's inquiry into family budgets), reducing the probability of errors in different directions. Errors therefore can hardly be considered independent, as is required for the logic of this method.† The latter method can never give more than a statement that the true index number could hardly lie outside certain limits, i.e., it is very probable that it lies within these limits—but once we put it in this way, the limits can be narrowed substantially; in particular we must allow for the low probability of separately unlikely errors occurring in combination. The probability of the calculated error margins for the index number being exceeded is not 0, but it can be expressed as 10^{-x}, where x is a very large (but unknown) number. The only "extreme errors" which would be interesting would be those produced by plausible variations in the basic assumptions. Mr. Roy recognizes this: in support of his absolute error margins he shows the distributions of middle-class expenditure which would produce them, and asks whether anyone would call these distributions "quite impossible". This is a tricky question, because one could hardly ever accept the responsibility of calling any distribution "quite impossible". The relevant question is whether they are reasonably plausible *as distributions*, and these distributions do seem rather far-fetched. One implies that less than 1½ per cent. of expenditure in 1938 was devoted to fuel and light, and much more to clothing than to food; while the other suggests that less was spent on drink, tobacco and domestic service put together than on travel. The "lower extreme" error really depends on the belief that the C.S.O. may have greatly over-estimated 1938 expenditure on all the goods whose prices have risen most since 1938 (drink, tobacco, domestic service, etc.): such errors are separately unlikely, since many goods underrepresented in family budgets (and possibly other sources of information) will have been subject either to heavy taxation or to considerable rises in factor cost since 1938. A combination of

* It is not necessary, as a reader might assume, to make specific assumptions about the distribution of non-working class expenditure. If, as seems possible, he worked out these error margins from the errors in this implied distribution they will be incorrect, because the estimate of the middle-class price relative obtained for each commodity depends on the estimate of how much the middle classes spent on it. If the expenditure estimate is subject to error, so is the price relative, whereas he treats price relatives as data.

† It is surely optimistic to say that "there would be no difficulty" in taking account of particular assumptions about associations of error. In practice these assumptions could hardly be converted into numerical propositions.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

such errors is impossible—to all intents and purposes. The error these over-estimates would have collectively produced in the index is therefore of virtually no interest.*

The former method is, however, of some value: it does not pretend to give more than the implication of various hypotheses. But the latter method is rather misleading, and gives a margin perhaps too low to be absolutely certain, although far too high to be a meaningful statement of the error to which the index may in practice be subject.

Mr. Roy's paper may therefore have led the careful reader to the conclusion that my estimates were subject to rather narrow margins of error, a conclusion I ought to correct. Actually he has discussed the effects of only one type of error—that in weighting. An important omission is an assessment of errors in price relatives. "In order to retain a reasonable degree of simplicity" he assumes these errors "negligible", adding that they might reduce the error in the index, since "they might be correlated appropriately with the estimates of the weights". This seems a hazardous assumption. My own experience with these index numbers is that if one takes all the problems of quality variation into account, and the fact that one cannot get price relatives which are internally 1938-weighted,† the errors to which the price relatives are subject are more serious than weighting errors.

This summary dismissal of a major source of error surely in itself renders worthless the estimates (i) that the probability of the real index being within 4·4 points of the calculated index is 95 per cent., and (ii) that the index is certain to be within 17 points. Quantitative statements of probability can hardly be derived from an assumption that an improbable hypothesis is correct. Yet no attempt is made to qualify these estimates or to assess their sensitivity to plausible changes in the basic assumption—although the paper repeatedly demands such qualifications for estimates and such assessments. The author seems to forget that estimates of errors are themselves derived statistics subject to error.

Is the reason for this rather unreal assumption that it would have been almost impossible to carry out the exercise if account had been taken of errors in both price relatives and weights (and of all the association between errors)? It is hard to avoid the conclusion that what has been demonstrated is, not the practicality, but the impracticality of the rule to show error margins for every estimate published. Even in the example chosen for illustration, it has not been possible to show errors which convey any meaning, let alone the meaning they appear to convey. With other guesses about the size, distribution and association of errors in the weights, and allowing for errors in the relatives, another research worker might reach errors half or twice as large.

No doubt most statisticians pay too little attention to sources of error, particularly in official statistics, and we ought more often to show the effect of varying basic assumptions. But is not the only general solution to reveal fully one's sources and methods, and give one's own assessment of the answer in the light of the purposes for which it is designed?‡ Publishing error margins with spurious precision may mislead still further an unfortunately gullible public.

* Mr. Roy also argues that these extremes would only imply an error of 2·6 per cent.—"a very modest margin of error indeed"—in the official estimates of total consumer expenditure. This is hardly relevant: very weird distributions of expenditure could still be consistent with the official estimates of the total.

† The separation of domestic service from other services in the 1950 National Income White Paper substantially raised the index, because it enabled a pre-war weight to be given to domestic service instead of what was implicitly a (much lower) post-war weight ("The Levelling of Incomes", p. 21).

‡ Just in case any reader should have gained a contrary impression from Mr. Roy's paper, I should like to emphasize that I discussed errors throughout the series of papers concerned and, in the introduction to "The Levelling of Incomes since 1938", I warned readers that "these calculations are based on the estimates in the National Income White Papers, which are only estimates, subject to substantial error margins . . . A further important caution should be borne in mind. These estimates shown here ought to have the word 'implied' before them . . . The method generally is to place two estimates side by side and see what their movements jointly imply". The purpose of these calculations, as the introduction to my first book says, "was to estimate the changes in the real incomes of various social classes and in their shares in the net national product". The introduction to the second book points out "the justification, and the only possible justification, for drawing conclusions is that the changes in the economic structure have been so marked that the same trends would be shown whatever error margin is allowed for official estimates and my guesses".

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Industrial Wages Bill and Earnings of Operatives in 1935 and 1948

By H. Leak

The adoption of the Standard Industrial Classification for post-war Censuses of Production resulted in many changes in the industrial classification of firms. The figures for 1935 and 1937 have been brought into line with the 1948 figures in the published results of the census for that year. When I was Adviser on Statistics in the Board of Trade I prepared estimates of the total wages paid in 1935 to the operatives employed by the firms now classified to the various trades, in so far as this was practicable from the available data, in the hope that these might be included in the published reports of the 1948 Census. This has not been done, and the object of this note is to place those estimates on record.

There are a number of cases in which the pre-war industries have been split in the new classification, e.g., mechanical engineering, or starch and polishes. For those divisions no estimate of wages has been made, though if the labour involved had been justified it would have been practicable to divide the original wages returns for 1935 according to the revised classification of the firms, and if the sample had been adequate, estimates of wages could have been made for the various sub-divisions. It is, however, possible in these cases to group the 1948 figures to correspond with the 1935 figures, and thus enable comparate figures of wages to be given.

Firms engaged in repair work for the general public were excluded from the 1948 Census but were, so far as identified, included in the 1935 figures. This could have some effect on the comparisons of average earnings in the two years for the boot and shoe trade and the motor vehicles and cycles (repairing) trade, but any lack of comparability is believed to be negligible, since the figures in both years exclude all firms employing fewer than 11 persons and most of these firms are in that category.

The Board of Trade were prohibited by the Census of Production Act, 1906, from requiring particulars of wages paid to be given. Voluntary inquiries on this subject were, however, conducted by the Ministry of Labour and, by arrangement with that Ministry, the total wages bill was ascertained for all those firms that made returns to the two departments on a more or less comparable basis. For various reasons comparability could not be secured in all cases, and accordingly it was not found possible to make use of all the wages returns supplied to the Ministry of Labour, and these were never quite complete. The precise total of wages paid could not, therefore, be given for any industry. The 1935 Census covered Northern Ireland, and the Ministry of Commerce, Belfast, obtained voluntary wages returns from firms there, which were incorporated in the published reports with those furnished to the Ministry of Labour. Four measures of the size of the sample in an industry were available, and in the Final Report on the 1935 Census particulars were given of the proportion of the trade which the firms furnishing wages returns represented in terms of gross output, of net output, of operatives and of other persons employed. The figures for operatives were given in relation to the average for the year and to the numbers of males and females employed in October. In the majority of cases the proportions corresponded closely, but in some cases there were fairly wide differences. This applied particularly where there were well-defined sections of a census trade employed on rather divergent activities. The existence of such divergencies is well shown by the 1948 figures for some subdivided industries, e.g., for chemicals, dyestuffs and drugs, average wages varied from £224 to £375; for preserved foods, from £201 to £258; and for electrical engineering from £235 to £281. In few industries, however, was the sample so unrepresentative as to cast any doubt on the substantial accuracy of the estimate.

In a small number of cases it is not possible to give corresponding figures for 1935 and 1948, owing to structural changes. The spirit rectifying and compounding trade, for example, now excludes the firms engaged in methylating spirits; as the omission is relatively large and no separate

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

figures are available for the wages paid by the methylating firms, it would be hazardous to guess the figure for 1948 corresponding to 1935 or vice versa. The firms engaged in methylating spirits are, however, such a small section of the post-war chemicals, dystuffs and drugs trade as not to exert a disturbing effect on the comparison for that trade.

In the majority of cases changes in the 1935 figures to fit those for 1948 are relatively small. If larger, it may still be practicable to provide a reliable estimate for 1935 provided there is no marked divergence between the average earnings in the main trade and in the trade from which the other firms came or to which they have been taken. Small differences between the 1935 employment figures as originally published and those given in the 1948 report may conceal relatively large movements in and out, which have to be allowed for. Changes in numbers employed cannot, therefore, be used as a measure of accuracy in the wages estimates. No wages estimate is practicable for the section of the linen and soft hemp trade located in Great Britain. In other industries the proportion of the industry located in Northern Ireland is not so great that the tendency for average earnings there to be rather lower than in Great Britain has any appreciable effect on the comparison between 1935, when the wages figures included Northern Ireland, and 1948, when the Census related to Great Britain only.

In the appendix I have given figures, wherever practicable, for the aggregate wages paid in 1935 in the industries distinguished at that census, but having the composition of the industry or aggregate of industries for 1948. The industry titles used are those of the current classification and footnotes show the allocation in doubtful cases. It cannot be assumed that the wages returns received were without error, but each was carefully scrutinized before being accepted for inclusion in the published results. Assuming no appreciable bias in the usable returns, the margin of error in the present estimates is not believed to be more than 1 per cent. for the great majority of trades. For the trades specially noted in the appendix the error may well exceed 3 per cent., either because of structural changes or because of the unrepresentative wages sample for 1935, and the margin of error may be a little above this for some of the small trades. For all practical purposes, 5 per cent. may be taken as the maximum margin of error. The figures relate to private firms; Government establishments have been excluded throughout except in the comparatively few cases where, for security reasons, no particulars of Government establishments have been given in the 1948 reports.

Figures are given in the appendix for the aggregate wages paid to operatives in 1948 comparable with those for 1935, together with the average earnings per operative in each year, and the ratio of average earnings in 1948 to those in 1935. The following tables show the industries having the lowest and the highest average earnings in 1935 and 1948, the industries being arranged in order from the lowest or highest, respectively.*

Average earnings are a combination of the earnings of all operatives—men, women, boys and girls—and because an industry appears in Table 1 it does not follow that wage rates were lower in that industry than in others. Nearly all the industries noted in Table 1 in which earnings were low in 1948 also had low earnings in 1935, the only newcomers to the list for all practical purposes being the lace and match trades.† In the lace trade the proportion of females rose from 62·0 to 62·8 per cent. of the total. In the match trade the proportion of juveniles (under 18) rose, very exceptionally, from 15·4 to 19·0 per cent. Over all, the proportion of female operatives fell from 27·6 per cent. in 1935 to 23·5 per cent. in 1948, while that of juveniles fell from 14·3 to 7·4 per cent.

In all the trades in which average earnings were low in 1948, the proportion of females was high, exceeding 62·5 per cent. in all cases except brushes and brooms (57·1 per cent.), and being as high as 83·8 per cent. in the large tailoring, dressmaking, etc. trade‡ and 93·0 per cent. in the small incandescent mantles trade.

Notable disappearances from the list of industries with low average earnings are both the cotton trades, in which there was a good deal of concealed under-employment in 1935.

Of the fourteen trades in which earnings averaged not less than £340 in 1948, there were five not included in the list with earnings £150 or more in 1935. The outstanding addition is coal

* No significance is to be attached to the precise limits taken. They have been adopted to give about the same number of industries in each year in each table.

† Wages in both preserved foods and biscuits averaged about £90 in 1935.

‡ Not including hats, caps and millinery.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

mines, where the average earnings of £390 in 1948 were only exceeded by those in the very small cinematograph film printing trade. Eight of the industries predominantly employ adult males, the proportion of the total varying from 92·0 per cent. in the iron and steel melting and rolling trade to 97·4 per cent. at both blast furnaces and coke ovens and 98·1 per cent. in the manufactured fuel trade. The other four industries are coal mines, shipbuilding, cement and mineral oil refining.

TABLE 1

Industries with the Lowest Earnings per Operative in 1935 *and* 1948

Average Earnings under £90 *in* 1935	*Average Earnings under* £215 *in* 1948
Flock and rag.	Incandescent mantles.
Rope, twine and net.	Gloves.
Leather goods.	Jute.
Games and toys.	Canvas goods and sack.
Cotton spinning and doubling.	Rope, twine and net.
Cotton weaving.	Leather goods.
Tailoring, dressmaking, etc.*	Hosiery and other knitted goods.
Canvas goods and sack.	Tailoring, dressmaking, etc.†
Gloves.	Umbrellas and walking sticks.
Umbrellas and walking sticks.	Lace.
Incandescent mantles.	Match.
Cardboard box, carton and fibre board packing case.	Preserved foods.
Hair, fibre and kindred trades.	Brushes and brooms.
Jute.	Games and toys.
China and earthenware.	Biscuit.
Hosiery and other knitted goods.	
Brushes and brooms.	
Cutlery.	

* Including or excluding hats and caps (£104).
† Including or excluding hats, caps and millinery (£225).

TABLE 2

Industries with the Highest Earnings per Operative in 1935 *and* 1948

Average Earnings £150 *or more in* 1935	*Average Earnings* £340 *or more in* 1948
Newspaper and periodical printing and publishing.	Cinematograph film printing.
Mineral oil refining.	Coal mines.
Cement.	Blast furnaces.
Iron and steel melting and rolling.	Newspaper and periodical printing and publishing.
Cinematograph film printing.	Iron and steel melting and rolling.
Ice.	Mineral oil refining.
Manufactured fuel.	Cement.
Sugar and glucose.	Coke ovens and by-products.
Blast furnaces.	Motor vehicles and cycles (manufacturing).
Precious metals refining.	Shipbuilding and ship repairing.
Brewing and malting.	Aircraft manufacture and repair.
Coke ovens and by-products.	Non-ferrous metals (smelting, rolling, etc.).
Abrasives.	Manufactured fuel.
Grain milling.	Tinplate.
Motor vehicles and cycles (manufacturing).	

Three newcomers to the list are non-ferrous metals, shipbuilding and aircraft, in which employment respectively doubled, doubled and trebled between 1935 and 1948. In tinplate a rather more than average rise in earnings brought the industry above the limit taken for 1948 from below £150 in 1935, though average earnings had exceeded that figure in 1930. The food and drink trades have all disappeared.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Industries with the Highest and Lowest Increases in Average Earnings between 1935 *and* 1948

Increase of 170 *per cent. or more*	*Increase under* 100 *per cent.*
Shipbuilding and ship repairing.	Newspaper and periodical printing and publishing.
Coal mines.	Starch and polishes.
Flock and rag.	Match.
Cutlery.	Brewing and malting.
Fellmongery.	Ice.
Cotton weaving.	Soft drinks, British wines and cider.
Cotton spinning and doubling.	Incandescent mantles.
Hardware, hollow-ware, metal furniture and sheet metal.	Printing and publishing, bookbinding, etc.
Building materials.	Precious metals refining.
	Tobacco.
	Lace.

The three industries with average earnings in 1948 more than three times those in 1935 are shipbuilding and ship repairing, coal mines and flock and rag. Shipbuilding and ship repairing was rather a depressed industry in 1935, with average earnings barely £100, but with greatly increased activity earnings per operative in 1948 exceeded £350, having now become on a par with those in motor manufacturing and aircraft. With the still unsatisfied need for more coal, coal mining had by 1948 become the industry (with one minor exception) with the highest average earnings from being rather below the average in both 1930 and 1935.

The flock and rag trade was the one in which average earnings were the lowest in 1935, only about £70. The Ministry of Labour earnings and hours inquiry* shows that in October, 1935, more than 20 per cent. of the workers were on short time, but nearly as many were working more than the normal working hours. The Ministry of Labour sample included nearly twice as many males as females, but the Census of Production figures showed a preponderance of females in the proportion of 3 to 2. The Ministry of Labour figure for the earnings of females was the lowest in the textile group, but the average for all workers was not. The trade is not now distinguished separately in the Ministry's published returns. I have given this information in detail, though flock and rag is only a small trade, to illustrate difficulties met with in attempting to relate the Census of Production annual figures (estimated or factual) with those obtained from a sample by the Ministry of Labour (and National Service) for a specified week. The relationship has now been improved, since the Standard Industrial Classification, which was designed to ensure a similar classification of individual establishments to the various industries, has been adopted by both the Board of Trade and the Ministry of Labour and National Service. The abnormal increase in average earnings in the flock and rag trade since 1935 is due mainly to the changed composition of the labour employed in the industry, there being a reduction from 568 (11 per cent. of the total) to 118 (2 per cent.) in the number of young female operatives accompanied by a rise from 1872 to 2,862 in the number of adult males.

Operatives employed in the printing and publication of newspapers and periodicals had in both 1930 and 1935 very much higher average earnings than those in any other industry—£255 per annum in 1935, the next highest figure being £171. The increase of under 50 per cent. between 1935 and 1948 is much lower than any other, and may be ascribed to the prevailing practice of giving flat rate increases to all workers rather than percentage increases. The small increase is confirmed by the figures published in the *Ministry of Labour Gazettes* for March, 1937, and March, 1949, which show an increase of 46 per cent. in average weekly earnings between October, 1935, and October, 1948.

There is no association between increased activity in an industry, as represented by a greater number of workers, and a higher than usual increase in earnings, or vice versa. Of the nine industries noted above as having the greatest increases in average earnings, five were expanded and four contracted trades, while among the eleven industries showing the smallest increases, there were an equal number of expanded and contracted trades, one being on the borderline.

The range of increases in various groups of industries is shown as follows:

* *Ministry of Labour Gazette*, February, 1937.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Percentage Increase in 1948 *over* 1935

Metal trades	119–172	+ Precious metals (94), cutlery (196) and shipbuilding (255).
Textiles and clothing	113–176	+ Lace (98) and flock and rag (226).
Food and chemicals	71–146	
Building, clay, etc., and timber	110–170	
Other factory trades	112–170	+ Printing and publishing (newspapers (49), other (92)), incandescent mantles (90) and fellmongery (182).
Mines and quarries	133–153	+ Coal (230).

Of the industries mentioned as being outside the normal range for the group the only ones employing as many as 12,000 persons in 1948 are coal mines and shipbuilding and ship repairing. In both the food, drink and tobacco and the chemicals groups, the rise in average earnings was distinctly lower than in any of the other groups. In the latter the ranges are very similar and only five industries show a rise of under 110 per cent.

Definitions

"Operatives" were defined at the 1935 Census as covering all wage earners (including foremen, van and lorry drivers and warehousemen) employed in or about the factory or works, or in outside work of construction or repair. This definition was slightly different in 1948, works foremen being included among the administrative, technical and clerical employees and not as operatives. Inspectors, viewers and similar workers were specifically mentioned as included, and operatives engaged in outside work in Northern Ireland or elsewhere not in Great Britain as excluded.

"Wages" included all overtime payments, bonuses and commissions, but excluded payment in kind, travelling expenses, lodging allowances, etc. The figures are gross, before deductions for income tax, insurance, contributory pensions, etc.

APPENDIX

	Wages paid to operatives		*Average per operative*		
	1935	1948	1935	1948	1948 *as a proportion of* 1935
	£'000	£'000	£	£	*Per cent.*
Iron and steel trades:					
Blast furnaces	2,300	8,994	158	381	241
Iron and steel melting and rolling (*a*)	20,500(*b*)	62,688	170	373	219
Iron foundries (*c*)	13,100	34,965	132	335	254
Tinplate	3,000	5,244	142	344	242
Hardware, hollow-ware, metal furniture and sheet metal	9,500	39,754	99	269	272
Chain, nail, screw and miscellaneous forgings	5,300	18,779	106	279	264
Wrought iron and steel tubes	3,300	10,047	137	324	236
Wire and wire manufactures	2,800	8,832	130	299	230
Tool and implement	1,900	6,511	101	269	266
Cutlery	900	2,941	88	260	296
Needles, pins, fish hooks and metal smallwares	1,200	4,076	92	221	240
Small arms	150	381	127	301	237
Total	63,900	203,212			
Non-ferrous metals trades:					
Non-ferrous metals (smelting, rolling, etc.)	6,000	29,479	139	346	249
Precious metals refining	300	1,059	158	306	194
Brass manufactures	3,600	12,352	109	278	255
Jewellery and plate	2,200	4,548	103	263	255
Watch and clock	370	1,940	105	263	251
Total	12,500	49,378			

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	Wages paid to operatives		*Average per operative*		
	1935	1948	1935	1948	1948 as a proportion of 1935
	£'000	£'000	£	£	Per cent.
Engineering, shipbuilding and vehicles trades:					
Mechanical engineering	47,500	199,478	130	316	243
Electrical engineering	24,000	101,438	113	272	240
Shipbuilding and ship repairing	10,300	73,471	99	352	355
Motor vehicles and cycles (manufacturing)	27,000	93,714	150	353	235
Motor vehicles and cycles (repairing)	7,400	16,765	132	296	224
Aircraft manufacture and repair	4,400	32,936	147	351	239
Railway carriages and wagons and trams (*d*)	2,600	9,150	138	323	234
Carts, perambulators, etc.	600	1,521	110	242	220
Total	123,800	527,473			
Textile trades:					
Cotton spinning and doubling	14,300	32,375	81	223	275
Cotton weaving	11,200	22,159	81	224	276
Woollen and worsted (*e*)	21,100	43,467	108	230	213
Rayon, nylon, etc., and silk	8,700	17,245	106	252	238
Jute	2,000	3,085	87	191	220
Hosiery	9,300	16,986	88	201	228
Textile finishing	9,900	16,795	110	264	239
Lace	1,500	2,205	104	206	198
Rope, twine and net	1,000	2,351	72	197	272
Canvas goods and sack	640	1,981	84	195	232
Asbestos	620	3,203	126	287	228
Flock and rag	360	1,293	70	230	326
Hair, fibre and kindred trades	280	944	87	222	255
Roofing felts	160	416	134	330	246
Textile packing	470	554	112	257	230
Total (excluding linen and soft hemp, but including narrow fabrics)	84,200	168,090			
Leather trades:					
Fellmongery	230	396	103	290	282
Leather tanning and dressing	3,400	8,697	126	297	235
Leather goods	1,300	2,625	79	201	253
Total	4,900	11,718			
Clothing trades:					
Tailoring, dressmaking, etc.	29,800(*f*)	63,549	84	201	240
Hats, caps and millinery					
Boot and shoe	11,900	24,569	106	243	229
Glove	800	1,712	84	183	218
Fur	1,000	1,903	137	293	214
Umbrellas and walking sticks	210	454	86	202	235
Total	43,700	92,187			

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	Wages paid to operatives		*Average per operative*		
	1935	1948	1935	1948	1948 *as a proportion of* 1935
	£'000	£'000	£	£	*Per cent.*
Food, drink and tobacco:					
Grain milling	3,500	6,831	152	303	200
Bread and flour confectionery (*g*)	10,700	24,598	130	281	216
Biscuit	3,300	4,893	90	212	235
Cocoa, chocolate and sugar confectionery	5,800	9,715	94	223	237
Bacon curing and sausage	2,000	3,648	119	242	203
Preserved foods	3,700	12,457	90	209	232
Milk products and margarine	1,400	12,025	126	283	225
Sugar and glucose	2,500	4,838	161	320	199
Fish curing	550	1,538	111	226	205
Cattle, dog and poultry foods	730	2,592	120	295	246
Ice	260	165	166	306	184
Brewing and malting	6,900	16,132	157	285	182
Spirit distilling	410	1,204	149	313	210
Soft drinks, British wines and cider	1,500	3,758	122	230	189
Wholesale bottling	2,000	4,744	105	225	214
Tobacco	4,400	8,760	123	241	196
Total (including spirit rectifying and compounding)	49,700	118,133			
Chemical and allied trades:					
Chemicals, dyestuffs and drugs (*h*)	9,050	36,481	146	311	213
Fertiliser, disinfectant, insecticide, etc., (*i*)	990(*b*)	3,042	128	300	235
Soap, candles and glycerine; Toilet preparations and perfumery	2,300	5,251	109	236	226
Paint and varnish	1,850	5,582	138	279	202
Seed crushing and oil refining	1,550(*b*)	2,462	148	321	216
Oils and greases	610	1,526	135	286	212
Mineral oil refining	480	2,165	171	368	215
Starch and polishes	780	1,428	141	241	171
Match	400	691	115	208	181
Total (including explosives and fireworks and ink)	19,500	63,273			
Paper, printing and stationery trades:					
Paper and board	7,000	17,325	132	297	224
Wallpaper	580	814	114	252	221
Printing and publishing, bookbinding, etc.	21,500(*b*)	35,980	141	271	192
Newspaper and periodical printing and publishing	12,500	19,303	255	379	149
Manufactured stationery, paper bag, etc.	3,000(*b*)	7,551	95	221	233
Cardboard box, carton and fibre-board packing case	3,300	7,441	87	217	250
Miscellaneous stationers' goods	600	1,898	100	222	222
Total	48,500	90,312			

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	Wages paid to operatives		*Average per operative*		
	1935	1948	1935	1948	1948 as a proportion of 1935
	£'000	£'000	£	£	Per cent.
Timber trades:					
Timber	7,400	21,724	123	279	227
Furniture and upholstery and soft furnishings (*j*)	10,700(*b*)	23,535	115	296	258
Wooden containers and baskets	1,620	5,133	111	254	229
Total	19,700	50,392			
Clay and building materials trades:					
Brick and fireclay	11,100	20,674	130	318	244
China and earthenware	5,500	13,994	87	233	268
Glass	5,000	16,044	122	302	247
Cement	1,300	3,042	170	357	210
Building materials	4,000	15,585	121	327	270
Total	26,900	69,339			
Miscellaneous factory trades:					
Rubber	5,200	21,539	177	299	255
Scientific, surgical and photographic instruments, etc.	2,800	14,294	122	275	226
Plastic goods and fancy articles	1,600(*b*)	7,005	107	240	224
Coke ovens and by-products	2,000	5,600	155	355	229
Manufactured fuel	130	457	163	345	212
Linoleum, leathercloth, etc.	1,400	2,794	130	297	228
Musical instruments	1,200	1,562	139	304	219
Brushes and brooms	790	2,601	88	211	240
Toys and games	820	3,850	81	212	262
Sports requisites	740	1,685	107	236	212
Abrasives	360	1,575	154	326	212
Incandescent mantles	100	142	86	163	190
Cinematograph film printing	130	752	169	404	239
Total	17,300	63,856			
Building and contracting trade (*k*):	70,000	261,209	149	317	213
Mines and quarries:					
Coal mines	88,400	283,962	118	390	330
Non-metalliferous mines and quarries (other than coal, salt and slate)	6,900	13,091	140	326	233
Metalliferous mines and quarries	1,300	2,114	126	319	253
Slate mines and quarries	1,100	1,385	118	290	246
Salt mines, brine pits and salt works	500(*b*)	1,447	120	300	250
Total	98,200	301,999			
Grand Total	612,800	2,006,715			

(*a*) Including steel sheets.
(*b*) Approximate figure.
(*c*) Including some steel foundries in 1935.
(*d*) Excluding railway companies.
(*e*) Including carpets.
(*f*) Divided approximately £26·3 mill. and £3·5 mill.
(*g*) Including ice cream.
(*h*) Including coal tar products.
(*i*) Including glue, gum, paste, etc.
(*j*) Including baskets in 1935.
(*k*) Including shop fitting.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

Criminal Statistics

By T. S. Lodge

1. Statistics of crime and criminal proceedings are compiled separately for England and Wales, for Scotland, and for Northern Ireland. The bases adopted are not exactly the same, chiefly because the legal and judicial systems are different in the three countries; the differences between Scotland, on the one hand, and England and Wales and Northern Ireland, on the other, are the most material. This note deals principally with statistics relating to England and Wales, but the differences met with in the Scottish statistics are discussed briefly in paragraphs 49 and 50.

Statistical Publications

England and Wales

2. For England and Wales the statistics of crime and court criminal proceedings are contained in the *Criminal Statistics*, published annually after presentation to Parliament by the Home Secretary. Nearly all the statistics contained in this volume are collected by the Home Office from the police under the County and Borough Police Act of 1856, though some information is also obtained from the Court of Criminal Appeal, the Director of Public Prosecutions, coroners and other sources.

3. Information about criminals, though not directly about crimes, is also contained in the annual *Report of the Commissioners of Prisons*. This gives information relating to prisons and Borstal institutions, and contains statistics about the persons sentenced to imprisonment, corrective training, preventive detention or Borstal training.

4. As well as the two publications just mentioned, the Home Office makes available each year to research workers and libraries a collection of *Supplementary Statistics* which includes, among other things, figures showing how the courts in the different police districts dealt with persons found guilty of indictable offences; and the Children's Department of the Home Office publishes from time to time a report on its work which includes information and statistics about juvenile delinquency. H.M. Stationery Office publishes also a yearly House of Commons Paper giving statistics of offences relating to motor vehicles, and in 1951 published a Paper giving statistics of offences of drunkenness, by districts, for 1948, 1949 and 1950. It should be noted that the two last-mentioned papers show the number of *offences* proved, not the number of *persons* found guilty of each type of offence; consequently the figures are not comparable with the figures in *Criminal Statistics*. The annual *Report of Her Majesty's Inspectors of Constabulary* contains statistics of the establishment and strength of police forces throughout England and Wales.

5. The rest of the available statistical information on crime and criminals is either local, and published by local authorities, probation committees, police authorities and the like, or derives from research carried out privately or officially. In particular the annual *Report of the Commissioner of Police of the Metropolis* gives very full information about crime and police in the Metropolitan Police District.

Scotland and Northern Ireland

6. *Criminal Statistics, Scotland*, and *Report on Prisons in Scotland*, for which the Secretary of State for Scotland is responsible, follow broadly similar lines to the corresponding publications relating to England and Wales, and police statistics are given, rather more fully than those published for England and Wales, in the annual *Report of Her Majesty's Inspector of Constabulary for Scotland*. For Northern Ireland similar information, though in less detail, is contained in the annual *Report on the Administration of Home Office Services*.

7. The *Annual Abstract of Statistics* reproduces in a condensed form many of the statistics mentioned above.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CRIMINAL STATISTICS, ENGLAND AND WALES

8. The general plan of *Criminal Statistics* may be set out as follows:

(1) Offences known to the police.
(2) Persons dealt with by the courts, analysed by offence and age group:
  (*a*) Higher Courts (Assizes and Quarter Sessions).
  (*b*) Magistrates' Courts (including Metropolitan Magistrates' Courts, Juvenile Courts, etc.).
(3) Miscellaneous tables.

9. The discussion of *Criminal Statistics* which follows begins with some definitions and notes on the classification of offences, continues with an outline of the procedure whereby offences are recorded by the police, goes on to describe the statistical basis of the tables relating to persons dealt with by the courts, and ends with some notes on the interpretation of the figures.

Definitions and Classification of Offences

10. *Crime.*—In ordinary speech a crime is a fairly serious offence against the criminal law, and this is the only sense in which it is used in this article. There are various legal and criminological definitions of the word, but for statistical purposes it is more convenient to omit it from the vocabulary. It is, however, used in Scottish criminal statistics in a sense broadly equivalent to that of the term "indictable offence", which for the purpose of its use in the criminal statistics of England and Wales is defined below.

11. *Main groups of offence.*—The introductory note to *Criminal Statistics* deals with offences in three groups, and gives a total for each. The groups must therefore be defined as precisely as possible. They are:

(*a*) Indictable offences.
(*b*) Non-indictable offences.
(*c*) Offences against defence regulations.

12. Placing offences against defence regulations in a separate group is a device adopted for convenience. These offences could be divided between the other two groups. They are, however, of recent origin, and in their nature temporary, and it was therefore thought better to keep them separate and so avoid disturbing the continuity of the totals of the other groups.

13. *Indictable and non-indictable offences.*—An indictment is an accusation of a crime which is read to a prisoner brought before a court of assize or quarter sessions. At these courts the guilt or innocence of the accused person is decided by jury. In a magistrates' court the procedure of indictment is not used; instead the prisoner is charged with an offence by means of an information laid before the magistrates and the magistrates themselves decide on his guilt or innocence.

14. Subject to the exception of one class of offence which is discussed below (paragraph 16), an indictable offence is an offence which can be tried* on indictment. It should be noted that only some indictable offences *must* be tried on indictment; others, though they *can* be tried on indictment, can also be tried summarily.

15. The different kinds of indictable and non-indictable offences may be tabulated as follows:

I. *Indictable Offences*

(*a*) Those which can be dealt with only on indictment (e.g., murder);
(*b*) those which can be dealt with either
  (i) on indictment, *or*
  (ii) summarily, under the provisions of the Criminal Justice Act, 1925 (which extended the powers of magistrates to deal with indictable offences), if the court so decides and the accused person consents.

(e.g., most larcenies where the value of the property does not exceed £20).

* The definition of an indictable offence depends on the way in which an adult person accused of the offence can be tried; the special provisions about the hearing of charges against persons under 17 years of age must be ignored for the purpose of the definition.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(*c*) those which, by specific statutory provision, can be dealt with either on indictment or summarily at the discretion of the court (e.g., driving a motor vehicle while under the influence of drink or a drug).

II. *Non-indictable Offences*

(*a*) Those which can be dealt with only summarily (e.g., failing to have a wireless licence);
(*b*) those which can be dealt with either
  (i) summarily, *or*
  (ii) on indictment, if the accused person exercises a right to trial by jury under the Summary Jurisdiction Act, 1879 or certain other Acts (e.g., keeping a gaming house).

16. The last of these groups, II (*b*) (ii), is the exception referred to in paragraph 14. In certain circumstances a person accused of an offence (other than an assault) for which the maximum penalty is more than three months' imprisonment, and which but for this right would be tried summarily, may claim to be tried by a jury. It may be that there is some slight doubt whether in law these offences are properly called non-indictable, but for practical purposes they are treated as such.

17. In *Criminal Statistics* there are two complications to add to those of the definitions given in the preceding paragraphs. First, when recording the offences made known to them, the police do not in England and Wales record all offences but only those regarded as indictable. For this purpose they should *exclude* the offences in group I (*c*) of paragraph 15, that is those triable summarily or on indictment as the court may decide; they are sometimes referred to as hybrid offences. There is no longer any decisive argument of principle in favour of excluding them; only the need for consistent recording and continuity and the fact that many of them are trivial offences. They were originally left out because until the High Court recently ruled that they were indictable offences they were thought to be not properly so described. This is only one of a number of thorny points to do with the classification of offences; many of them have arisen out of the extension in the present century of the powers of magistrates' courts to deal with serious types of offence, and the great difficulty of adjusting the statistical system to keep in line with this and similar developments in law and practice. The distinction between indictable and non-indictable offences, which sixty years ago (when the foundations of the present classification system were laid) was a reasonably sharp one, has now become blurred, and it may be that at some time still in the future continuity will have to be deliberately broken in order to set up a system of classification more appropriate to modern conditions.

18. The total number of hybrid offences is quite large. Some of the more important are neglect or ill-treatment of children (recorded in the criminal statistics as *cruelty to children*), certain assaults, driving a motor vehicle while under the influence of drink or a drug, unauthorized taking of a motor vehicle and dangerous driving. Most of the remainder are rarely tried on indictment. There has hitherto been some confusion about the inclusion of hybrid offences in the returns of offences known to the police, with the result that every year a comparatively small number of some of these offences has been shown in the tables as known to the police. The correct procedure, as explained above, would have been to omit them altogether. The figures in, for example, Table A and Table I of *Criminal Statistics*, 1950, for any of the offences mentioned in this paragraph are therefore misleading and should be ignored; most of the hybrid offences, if recorded as known to the police, are included in the residual category *Other Misdemeanours*, so that the number of offences shown as known to the police under this heading may likewise be misleading.

19. The second complication referred to in paragraph 17 concerns once more the hybrid offences, group I (*c*), and this time is found in the tables of court proceedings. All offences, except offences against defence regulations, are grouped under certain classification numbers, indictable offences having the numbers 1 to 70 and non-indictable offences having the numbers 101 to 195. Indictable offences such as those in group I (*b*) of paragraph 15, that is, those which can be tried summarily under the Criminal Justice Act, 1925, have only one classification number, not greater than 70, and they are recorded under this number in the tables of proceedings in magistrates' courts as well as in the tables of proceedings in higher courts. Hybrid offences, that is those in group I (*c*), have each two classification numbers, one for use if they are dealt with in a higher

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

court and the other for use if they are dealt with in a magistrates' court. For example, cruelty to children comes within the classifications 11 and 109.

20. The offences in group I (*a*) of paragraph 15, which can be tried only on indictment if the accused person is an adult, are (excepting offences of homicide) in general dealt with at a juvenile court if the accused person is a child or young person, that is if he is aged 8 but less than 17. This does not, fortunately, introduce any further complications into the tables, but only has the effect of bringing into the tables of proceedings at magistrates' courts figures which relate only to juveniles.

21. *Further classification.*—Within the three main groups of offences detailed groupings have been standardized for statistical purposes. Indictable offences are grouped for publication under 70 headings divided into the following six classes:

I. Offences against the person.
II. Offences against property with violence.
III. Offences against property without violence.
IV. Malicious injuries to property.
V. Forgery and offences against the currency.
VI. Other indictable offences.

This grouping into six classes is probably justified only by its antiquity and is not a particularly useful one for statistics. There is, for example, little justification for grouping offences of violence against the person together with sexual offences, and classes IV and V are not large enough or important enough to be separate classes. A somewhat different grouping is used in the Introductory Note to *Criminal Statistics* to compare the figures for one year with those for another. The headings are as follows:

Violence against the person.	Larceny.
Sexual offences.	Receiving.
Breaking and entering.	Frauds and false pretences.
Robbery.	Other offences.

The numbers of the offences included in the groups are given on page v of the introductory note to *Criminal Statistics*, 1950. This grouping, too, has its faults, particularly in the *violence against the person* and *sexual offences* groups, where very ill-assorted offences are placed together, but the claims of continuity (which has an importance in criminal statistics at least as great as its importance in other fields) make it doubtful whether an alteration would be worth while.

22. Two-thirds of the convictions for non-indictable offences are for traffic offences. The total number of persons found guilty of non-indictable offences is therefore useful, if at all, only to show the burden of work in magistrates' courts. The many hundreds of non-indictable offences are grouped for publication into 92 more or less homogeneous groups, and so far no way of arranging these in a smaller number of groups has been standardized. Some offences, such as traffic offences, fall naturally into groups, and it may be possible in the future to work out a satisfactory grouping system.

Offences known to the Police

23. When an indictable offence is committed, what happens is roughly as follows: First, in general the police are notified. If the police do not come to hear of the offence, it has no official existence. Indictable offences of certain kinds are reported to the police in only a small proportion of cases, and the real amount of such crime cannot be learnt from available statistics; examples are shoplifting, some sexual offences, and blackmail.

24. On learning that an indictable offence has been committed (this applies also to a certain number, varying in different police forces, of non-indictable offences) the police make an entry in a crime complaints book. They then make an initial inquiry into the offence, decide for record purposes what kind of an offence it is, and record it as an indictable offence known to the police. If at this point or later during the year they find that no offence, or only a non-indictable offence, has been committed, they write off the entry as "no crime"; otherwise (except for crimes of murder, which are treated specially) the offence remains in the statistics under the classification given to it after initial inquiry, notwithstanding any development—such as a court decision, or new evidence—which might make another classification more appropriate. Statistics of indictable offences known to the police are given to the Home Office monthly and yearly, but only the yearly figures

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

are available for publication; the monthly figures over a year do not, of course, add up to the yearly total because they do not allow for offences written off as "no crime" during the remaining part of the year.

25. Some of the indictable offences known to the police are cleared up and some remain unsolved. The meaning of "cleared up" for statistical purposes is defined in instructions issued by the Home Office; offences cleared up include those for which a person is arrested or summoned, those taken into consideration by a court when passing sentence for another offence, some of those of which a person is known or suspected to be guilty but for which for some reason he cannot be prosecuted (e.g., because he dies), and those for which an offender is formally cautioned by the police. The police returns to the Home Office show the number of indictable offences of each kind cleared up during a calendar year, but it is never possible to say (unless by special research) how many of the offences committed during a year are ultimately cleared up; the time-lag error tends, however, to cancel itself out at each end of the calendar year and is not of any great consequence. It will be clear that some kinds of offence are by their nature cleared up much more readily than others; thus offences of attempted suicide or perjury are cleared up virtually always, because the offence is not ordinarily heard of unless the offender is known, but larcenies and breakings are cleared up in only a modest proportion of cases. The following table shows, by offence groups, the indictable offences cleared up in 1950 expressed as percentages of the offences known to the police in that year.

TABLE 1

Offence Group	*Number of Offences Known to the Police in* 1950	*Ratio* (× 100) *of Offences Cleared up in* 1950 *to Offences Known to Police in* 1950
Violence against the person	6,249	90
Sexual offences	13,185	78
Breaking and entering	92,839	38
Robbery	1,021	54
Larceny	301,075	40
Receiving	7,586	100
Frauds and false pretences	25,561	93
Other offences	13,919	84
All indictable offences	461,435	47

These figures show that the percentage in the total line is controlled mostly by the percentage of crimes of larceny and breaking and entering which are cleared up. At the same time, a substantial rise, relative to the total offences, in the annual number of (say) offences against the person, such as has in fact taken place over the past twelve years, would produce a small increase in the percentage of all indictable offences cleared up even though the percentage cleared up in each group remained the same.

26. The methods of recording crimes used by police forces have varied very considerably over past years, with the result that statistics of offences known to the police have to be treated cautiously. For instance in the Metropolitan Police District there was a change in practice in the middle of 1932 which caused certain figures to perform a phenomenal leap. The table below shows the numbers of offences of simple and minor larceny in certain years:

TABLE 2

Metropolitan Police District: Offences of Simple and Minor Larceny Known to the Police

Year	*Number of Offences*
1925	5,298
1930	7,036
1931	9,534
1932	34,783
1933	54,018
1934	53,492

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

27. The Departmental Committee on Detective Work and Procedure, which reported in 1938, recommended codes of practice in recording offences which have caused a marked improvement, and the post-war figures are certainly more reliable than the pre-war figures. There is still, however, some way to go before uniformity of practice among different forces is attained. When a satisfactory basis for the statistics of offences known to the police can be established, these figures should give the best indication obtainable of the state of crime in the country. Their advantages over the statistics of court proceedings are that they eliminate the differing degrees of success of the police in clearing up different kinds of offence, and that they avoid the complications introduced into statistics of court proceedings by repeated convictions of the same person and the taking of offences into consideration by courts in passing sentence. They have the disadvantages, on the other hand, that by the system at present followed an offence (other than murder) may be entered under a heading which later court proceedings show to have been the wrong one; and that there are variations by both time and place in the extent to which offences are reported to the police.

28. Two further points of difficulty may be mentioned here. The first relates to continuing offences. When, for example, a thief breaks into a block of offices and enters the premises of several different firms, a separate offence is recorded for each firm. If the offices all belonged to the same firm only one offence would be recorded. Similarly, systematic frauds against a number of people count as a separate offence for each person defrauded. The effect of this method of recording on the number of crimes known to the police may be considerable, because it is not uncommon for dozens of offences, committed by the same person, to be discovered at the same time.

29. The second point of difficulty concerns offences committed in places where special police forces operate, such as the railway police or dock and harbour police. Unless a criminal is identified, in which event the case may be handed over to the ordinary police for prosecution, these offences are not recorded in *Criminal Statistics*. It is believed that large numbers of offences of theft are at present missed in this way (see Silcock, 1949).

Statistics of Court Proceedings

30. A person thought to be guilty of an indictable offence may be summoned to appear before a court of summary jurisdiction, or apprehended and brought before it. He is then charged with the offence and the court may—

(1) Discharge him on the grounds that there is insufficient evidence to put him on trial; or

(2) Deal with the case summarily (provided that the necessary conditions are fulfilled); or

(3) Commit him for trial at a higher court; or

(4) Dispose of him in some special way, e.g., hand him over to the Naval, Military or Air Force authorities or have him sent to a mental hospital.

If the offence is non-indictable, only alternatives (2) and (4) are available to the court (unless the accused person himself exercises the right available to him in certain circumstances to be tried by a jury).

31. The total number of persons dealt with in any of these ways is described in *Criminal Statistics* as the number of persons proceeded against. These figures tell usually much the same story as the number of persons found guilty; though in the case of a few offences, in particular common assault (non-indictable), the number of charges withdrawn or dismissed is proportionately fairly large.

32. The numbers of persons dealt with summarily and the numbers of persons for trial at assizes or quarter sessions in calendar year periods happen to have been tabulated for many years in tables showing the figures for successive years, or averages of five-year periods, in adjacent columns. They are therefore the easiest figures to use when a comparison over a long period is required; with the help of only two or three recent volumes of *Criminal Statistics* it is possible to follow the statistics of court proceedings for most offences back to the year 1900. Table 3 gives figures for a few types of offence for selected periods and for 1950:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 3

Persons for Trial or Dealt with Summarily

Offence Classification Numbers	*Offence or Offence Group*	*Annual Averages*				
		1900–1904	1920–1924	1935–1939	1945–1949	1950
1	Murder	69	63	56	72	77
5, 8	Felonious and malicious wounding	837	436	1,607	2,710	3,984
20	Indecent assaults on females	434	977	1,239	1,906	2,383
27 to 33	Breaking and entering	2,485	4,273	10,485	22,138	21,196
37 to 49	Larceny	47,056	45,322	59,213	80,819	77,512
11,109	Cruelty to children	3,945	1,793	973	1,225	1,051
166*	Offences by prostitutes	10,598	4,317	3,053	4,622	6,868
140,141	Drunkenness	216,424	85,160	51,486	25,876	45,961

* 168 up to and including 1949.

33. The most frequently used measure of the amount of any kind of crime dealt with by the courts is the number of persons found guilty. This is given in tables which show also the punishment or treatment awarded or other method by which the case may have been disposed of. The expression "found guilty" may be used instead of "convicted" so as to include children and young persons, against whom summary convictions cannot be recorded; and, when past years are being considered, so as to include persons dealt with summarily under the Probation of Offenders Act, 1907, in whose case the charge was found proved but against whom no conviction was recorded. Under Section 3 of the Criminal Justice Act, 1948, which came into force in 1949, it is proper to speak of a conviction when an adult offender is made the subject of a probation order.

34. The statistical basis of the tables relating to court proceedings needs to be described carefully. A criminal may be proceeded against more than once during a calendar year, may be convicted of several different offences on each occasion, and moreover may ask on each occasion that a number of other offences, with which he has not been charged, shall be taken into consideration when sentence is passed. It is impossible to record every aspect of this situation in ordinary tables, and the method of tabulation used in *Criminal Statistics* counts such an offender once* for each separate occasion on which he is proceeded against, records only the principal offence of which he is convicted, ignoring the rest, and ignores also any offences taken into consideration by the court in passing sentence. For example, at all courts in 1950, for all indictable offences taken together, the number of different persons found guilty was 109,911, the number of principal offences of which they were found guilty was 116,021, and the total number of offences of which they were found guilty was 148,401. There is no record of the number of offences taken into consideration. The only one of these figures recorded in the main tables in *Criminal Statistics* was the second one, that is, 116,021.

35. The figures in the preceding paragraph were derived from an analysis carried out for the first time in relation to the figures for 1950; this had been made possible by asking the questions on the dual-purpose punched cards, completed by the police, whether the proceedings against a person were the first during the year or not, and how many additional convictions were recorded at the same time as the principal conviction. The figures quoted were published in the introductory note to *Criminal Statistics*, 1950. In these tables, however (and similarly in 1951), to have divided the number of different persons found guilty between higher courts and magistrates' courts was unsound; the number tabulated as (say) the number of different persons found guilty at higher courts was really the number of persons found guilty at higher courts who had not previously during the year been found guilty *at any kind of court*. To eliminate this rather obscure statistic the corresponding tables for 1952 are to be tabulated for higher courts and magistrates' courts combined, and a similar alteration will be made in the appropriate tables of the Supplementary Statistics (see paragraph 36).

* There is one exception to this; if a person is proceeded against at the same time for an indictable offence and a non-indictable offence he is treated as two persons. This somewhat out-of-date practice arose from a desire to keep statistics of indictable offences and statistics of non-indictable offences in water-tight compartments.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

36. In the Supplementary Statistics for 1951 a new section (Group III) was added giving, in respect of persons found guilty of each type of indictable offence, information about the indictable offences previously proved against them, the indictable offences taken into consideration by the court in passing sentence, and the additional offences of which they were found guilty at the same time as they were found guilty of the principal offence. These tables are complicated and difficult to understand, but when they have been continued for a few years analysis of them should throw some fresh light on the statistical picture of crime.

37. *Sentences, orders, etc.*—The main tables in *Criminal Statistics* analyse the number of persons found guilty of offences according to the sentence imposed or the order made by the court. It is to be noted that an order of absolute or conditional discharge is a method of disposal following a conviction (or, in the case of juveniles, a finding of guilt); it is different from the discharge referred to in paragraph 20 (1) above, which occurs when there is insufficient evidence to justify proceeding with the case. In general the present practice is to record in the tables the heaviest sentence awarded, additional sentences or orders for the same or additional offences being ignored. Exceptions to this are, however, that in the tables for assizes and quarter sessions sentences of imprisonment running consecutively are aggregated, and that in the tables for magistrates' courts two forms of additional sentence or order, namely fines and recognizances, are recorded. The figures for the additional sentences or orders are, however, not reliable and these columns may in future be omitted.

38. *Miscellaneous statistics.—Criminal Statistics* contains a number of tables relating to criminal proceedings besides those already mentioned (it also contains a few statistics about non-criminal proceedings). Most of these are comparatively straightforward records of events; it may, however, be worth mentioning two points which have sometimes caused confusion. The analysis of probation orders (Table XIV, 1950) includes all orders, whether for the principal offence or for an additional offence dealt with by the court at the same time as the principal offence; consequently the number of persons analysed in this table is greater than the aggregate number of persons recorded in the main statistical tables as placed on probation. Secondly, the table relating to the Court of Criminal Appeal does not confine itself wholly, so far as appeals heard or otherwise disposed of are concerned, to the calendar year to which the statistics in general relate, but analyses the disposal of cases in which leave to appeal was granted during the calendar year (as well as certain other cases actually disposed of within the calendar year); the method of tabulation will, however, be altered in the statistics for 1952.

Interpretation of Criminal Statistics

39. The work of the courts is recorded in *Criminal Statistics* with substantial accuracy. If this is the information required from the statistics it is only necessary to bear in mind the limitations of the tables in the recording of multiple offences, offenders and punishments, and exercise due care in quoting from them. Similarly, if it is required to know the number of crimes known to the police, the answer can be found subject, in recent years, to only a moderate degree of error. It is, however, seldom that a student of criminal statistics is looking for what is to be found there; he is more likely to be concerned with, say, the state of crime in the country, or the amount of delinquency in a particular age-group of the population. The criminal statistics do not contain such information, though they contain figures related to it. The interpretation of the statistics is not unlike attempting to draw a man's picture from his shadow on a wall—or, if non-indictable offences are in question, from his shadow on wire-netting.

The amount of information which the statistics directly provide is limited, but they show in what directions further inquiry should be made, and this is one of their essential functions. Research must be carried out before any aspect of crime can be fully understood, and there is scope for very much more research than can be carried out at present. It does not seem likely, however, that any method of inquiry will provide wholly reliable figures for the number of offences committed or for the distribution of such offences among the different age-groups.

40. For discussions of the interpretation of criminal statistics, reference should be made in the first place to Mannheim (1940), Radzinowicz (1945) and Grünhut (1951). It may be useful here to consider briefly, without encroaching on the territory of criminologists, the methods of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

approach which seem the most profitable when the object is to derive from the statistics such pointers to the underlying situation as they contain.

(i) There is little evidence to show what proportion of the offences of any class committed become known to the police. This is discussed in many of the references, particularly by Sellin (1951). It is usually desirable, therefore, to regard the statistics as purely relative, and consider only their upward and downward movements over a suitable period. This is to exchange ignorance of the proportion of offences becoming known for ignorance of the way in which this proportion changes from time to time; but it is generally agreed that this time-series approach reduces the error to something more manageable. Allowance must, of course, be made for any known or suspected disturbing factors, and it is best to leave out the war years altogether, except in special circumstances.

(ii) It is usually best to consider one offence, or a fairly homogeneous group of offences, at a time. The total of non-indictable offences measures little but traffic offences, and the total of indictable offences conceals movements in anything but offences against property. The following table shows how the indictable offences known to the police of wounding and of indecent assaults on females (selected as representative of offences of violence against the person and of sexual offences respectively) increased continually during the past few years while the total of indictable offences fell considerably in 1949.

TABLE 4

Indictable Offences known to the Police

Offence Classification Numbers	*Offence*	1946	1947	1948	1949	1950
5 and 8	Felonious and malicious wounding	3,008	3,480	4,193	4,330	5,177
20	Indecent assaults on females	4,659	5,052	5,659	6,191	6,678
27 to 33	Breaking and entering	115,058	111,789	112,665	91,445	92,839
37 to 49	Larcenies and embezzlement	310,650	330,918	349,358	301,591	301,075
—	Other indictable offences	39,114	47,337	50,809	56,312	55,666
1 to 70	All indictable offences	472,489	498,576	522,684	459,869	461,435

(iii) Only large changes or persistent trends can be relied on with any degree of safety to have a cause that it is worth while to investigate. It is usual, unless some other explanation suggests itself, to assume as a working hypothesis that when a trend is found like that of wounding offences in Table 4, a large part or all of it arises from a real increase in the number of offences committed. While this is quite justifiable, there should nevertheless be borne in mind the possibility of factors such as improved police methods, greater readiness by the public to report the offence, a court decision affecting the name given to an offence, or other such changes. When considering non-indictable offences special care must be taken in interpreting even a marked change in the figures. The proportion of these offences for which someone is prosecuted is generally comparatively small, and there is correspondingly greater scope for variations in the number of prosecutions not resulting from variations in the number of offences. It is not to be assumed that the statistics of individual non-indictable offences are without value as an indication of the number of offences committed, but valid deductions are not easy to draw, and need to be based on a knowledge of the surrounding circumstances in addition to the bare figures. To take two examples, the figures in Table 6 for offences of drunkenness proved in all county boroughs of England and Wales most probably reflect a real increase in the amount of drunkenness; the following figures of persons found guilty of offences against the Wireless Telegraphy Acts could not be taken to show anything more than a variation in the amount of activity in enforcement: 1948, 5,382; 1949, 12,459; 1950, 3,149.

(iv) It is generally desirable to examine all the available statistics about whatever offence is being considered. The trend of the number of indictable offences known to the police may, for example, be different from that of the number of persons proceeded against, or it may be similar

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

but less or more pronounced. Figures to illustrate such differences are given in the following table:

TABLE 5

Relation between the Number of Offences Known to the Police, the Number of Offences Cleared up, and the Number of Persons Proceeded Against

Offence Classification Number		*Mean 1937 and 1938* (1)	*Mean 1949 and 1950* (2)	*Ratio* (2)/(1) (3)
8	*Indecent assaults on females*—			
	Offences known to police . .	2,488	6,435	2·6
	Offences cleared up . . .	2,016	4,457	2·2
	Persons proceeded against . .	1,358	2,414	1·8
41	*Larceny by a servant*—			
	Offences known to police . .	5,887	11,963	2·0
	Offences cleared up . . .	5,447	11,840	2·2
	Persons proceeded against . .	3,989	9,409	2·4
45	*Larceny from unattended vehicle*—			
	Offences known to police . .	23,643	31,727	1·3
	Offences cleared up . . .	6,955	7,278	1·0
	Persons proceeded against . .	4,154	3,438	0·8

(v) The figures for the different police districts, so far as they are available, may often be studied with advantage. If in a district, or group of districts, the trend is different from that in the rest of the country, possible reasons for the variation, and hence for the trends, may suggest themselves. In this kind of analysis it is necessary to keep an eye on movements of population, local slumps or booms, and similar changes which may have their effect on the number of offences. Examples of differences in short-term trends are to be found in *Offences of Drunkenness*, 1950 (Cmd. 8427), from which the following figures for a few northern county boroughs are taken:

TABLE 6

Number of Offences of Drunkenness Proved, 1948–1950

County Borough	1948	1949	1950
Stockport	78	54	81
Blackpool	95	130	99
Dewsbury	29	19	30
Birkenhead	127	132	208
Liverpool	1,207	1,621	2,868
Salford	335	391	515
Leeds	521	880	1,521
Middlesbrough	553	658	783
All County Boroughs, England and Wales* .	25,522	28,256	37,591

* Including London County and City.

(vi) Frequently figures for crime should be adjusted for changes in population if a true picture is to be obtained. This is especially necessary when examining statistics over long periods or when considering juvenile delinquency. An example may be obtained by taking the numbers of boys in two age-groups found guilty of indictable offences in 1938 and in 1946 to 1950; the figures are all reduced to percentages of the 1938 figure, and in the second part of the table are corrected also for changes in the population of the age-group concerned (as given in the Registrar-General's estimates). There is for this purpose no objection to using the total of the indictable offences, which are preponderantly offences of larceny and breaking and entering.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 7

Numbers of Boys Found Guilty of Indictable Offences, (I) *as percentages of the corresponding number for* 1938, (II) *expressed per unit of population in the age group, reduced to percentages of the corresponding figure for* 1938

Year	Age Group			
	8 *and under* 14		14 *and under* 17	
	I	II	I	II
1938 . . .	100	100	100	100
1946 . . .	135	147	123	145
1947 . . .	133	143	112	134
1948 . . .	168	180	137	168
1949 . . .	157	169	121	151
1950 . . .	167	178	126	155

It is worth mentioning in passing that care is necessary when comparing the figures for different years for males of military age, particularly for ages covering National Service. No information is readily available about the extent to which offences by serving men are dealt with by the military authorities, and in any case the opportunities and temptations to commit crime are very different in military life from those in civil life. Again, the population figures for different years may not be comparable, at least to the extent that any forces are serving outside England and Wales.

PRISON COMMISSION STATISTICS

41. Statistics about prisoners and Borstal inmates are necessary for the study of penology, prison and Borstal administration, and allied subjects. They also indicate indirectly the trend of a certain section of crime; being collected at a point further from the crime itself than other criminal statistics they require very careful interpretation but, if due allowance can be made for any distortion, they provide for a particular section of the field of study an enlarged picture which is not, for practical and economic reasons, obtained otherwise. Where the prison statistics overlap the criminal statistics there are sometimes apparent discrepancies between the figures. In general these are not of great importance and most of them are caused by differences in basis; for instance, sentences may be altered on appeal, or there may be different treatment of duplicate or multiple offences or sentences in cases where there is more than one conviction at the same time.

42. The two basic statistics relating to prisoners or persons under Borstal training may perhaps be said to be (*a*) the number of receptions, and (*b*) the "daily average population", of persons under sentence of imprisonment, corrective training, preventive detention or Borstal training, measured over a calendar year. The daily average population is the mean population computed at daily intervals. Certain complications arise in computing statistics of receptions, mostly having to do with the treatment for statistical purposes of persons received into prison more than once in connection with the same proceedings; thus a criminal might be detained in prison before trial, held in custody again between conviction and sentence, and received in prison for the third time with a sentence of imprisonment. It is the present practice, with a view to giving a fair picture of the number of persons taken in charge by the prison system, to count such a person as only once received. A person received in prison on remand before conviction and ultimately sentenced, say, to be fined, would be recorded as received "on remand or for trial not followed by return to prison on conviction". The system of recording just outlined creates difficulties at the end of a year, when some prisoners are awaiting trial or sentence, and it is probable that modifications of recording procedure will be introduced in order to improve the statistics and at the same time provide more information about the use of new provisions contained in the Criminal Justice Act, 1948, particularly under Sections 20, 25, 26 and 29. It should be mentioned that in the past the Reports have not always been explicit about the classes of persons to which particular figures related; for instance, care should be taken by cross-checking with other figures to find out whether or not persons sentenced to Borstal training, or persons sentenced by court martial, are included in statistics of receptions or populations where this is not plainly stated.

43. The size of the prison and Borstal population is a function of the annual number of the receptions and the average length of detention. Between 1904, when the number of receptions

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

reached its peak, and 1918, the annual number of receptions fell by more than 85 per cent. and has never risen again very materially, but the average length of sentence has increased during the past ten years so that the population is now (in 1952) about 24,000, or higher than the 1904 figure of about 21,000, after having been round about 11,000 for the whole period between the two wars. The present composition of the population as regards length of sentence is remarkably different from that of forty-eight years ago. An analysis of the population in 1904 is not available, but its composition has been estimated very approximately from the numbers of receptions, and is shown below together with figures for 1935 and the figures given in the most recently published Report.

TABLE 8

Average Population of Prisons and Borstals

Sentence	1904 (*estimated*)	1935	1949
Imprisonment:			
Less than 3 months	8,000	1,359	1,085
3 and less than 6 months	3,000	1,201	1,183
6 ,, ,, 12 ,,	2,500	1,776	2,218
12 ,, ,, 18 ,,	2,000	1,244	2,370
18 ,, ,, 36 ,,	1,200	887	3,099
Penal servitude or imprisonment for 3 years or over	3,200	1,687	4,114
Corrective training	—	—	408
Preventive detention	—	121	130
Borstal detention/training	—	1,873	3,363
Untried, civil and other prisoners	1,500	1,158	1,909
Total	21,400	11,306	19,879
Number of receptions on conviction	196,000 (approx.)	34,783	32,736

In considering this table it should be borne in mind that the population of England and Wales has increased by some 30 per cent. in the last forty-eight years, and that the proportions of women and of persons under 21 received into prisons have greatly decreased.

44. The average population of prisons and Borstal institutions, suitably analysed, indicates the load on the prison system, and is a measure not available from any source other than the Report of the Prison Commissioners. The method by which it is at present computed provides, however, only a fixed and limited analysis of the total so that the maximum use cannot be made of these figures. The statistics of receptions do not directly give much information about the load on the prison system, but show to what extent persons are committed to prison for non-payment of fines, and provide some information about the use of prisons for detention on remand and for the custody of so called "non-criminal" prisoners such as those committed for non-payment orders. They provide also more detailed information about persons sent to prison than is obtainable from *Criminal Statistics*. At present no figures are available to show the total number of persons received into prison not under sentence, but the number received, not having been convicted, who are not subsequently sentenced to imprisonment, corrective training, preventive detention or Borstal training, is published; the following table shows separately the numbers of persons imprisoned in 1949 under this head and as "non-criminal" prisoners:

TABLE 9

Receptions of Prisoners and Borstal Inmates in 1949

Committals:	*Number*	*Percentage*
On remand or for trial not followed by return to prison on conviction	10,178	21·0
By Civil Process for failure to comply with orders for payment of money, and other non-criminal prisoners	5,208	10·7
In default of payment of fines	4,329	8·9
With sentences of imprisonment without the option of a fine, corrective training, preventive detention or Borstal training	28,504	58·8
Other committals	274	0·6
Total	48,493	100·0

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

45. One of the purposes of statistics about prisoners is to show to what extent persons having served their sentences return to crime. The only way of finding this out accurately would be by careful research work, but it is possible to obtain a crude indication of the success of treatment by counting as failures only those who return to prison under sentence. For many years the prison statistics have contained a table showing the proportion of prisoners who, after a first sentence of imprisonment for a "finger-printable offence",* in certain years, have not returned to prison up to the date of computation. The tables have certain imperfections; for instance they are based on receptions into prison rather than on discharges, so that the exposure to the risk of reverting to crime after discharge is a little indefinite; but if used with care they provide interesting information about the extent to which certain classes of criminal return to prison. The following figures have been extracted from Appendix 10 of the Reports for the years 1933 and 1938:

TABLE 10

Prisoners who began a First Sentence of Imprisonment for a Finger-printable Offence in the year* 1930. *Percentage not known to have returned to prison before the end of* (a) 1933, (b) 1938

Age Group on first Reception	*Prisoners with no Previous Proved Offences Before First Imprisonment*		*Prisoners with Previous Proved Offences Before First Imprisonment*	
	Percentage Not Returned to Prison before the end of 1933	*Percentage Not Returned to Prison before the end of* 1938	*Percentage Not Returned to Prison before the end of* 1933	*Percentage Not Returned to Prison before the end of* 1938
17 and under 21 .	78	71	72	56
21 and under 30 .	83	78	74	64
30 and under 40 .	88	82	81	76
40 and over . .	94	91	87	82
All ages .	87	82	77	68

* Imprisonment in this table means imprisonment for not more than 2 years. Up to April, 1949, when penal servitude was replaced by imprisonment, 2 years was the longest sentence of imprisonment imposed.

46. It is intended to begin within two or three years a new series of tables like those in Appendix 10 of the Report, based on discharges instead of receptions, and covering persons who have completed first sentences of corrective training, preventive detention or Borstal training as well as those who have been imprisoned. Imprisonment in the new tables will include imprisonment for periods of three years or more as well as for shorter periods; the longer and shorter sentences will be treated separately. These tables will show how far the treatment ordered has resulted in the non-return to prison of the persons sentenced, but it must be understood that they will not apply any correction for variation in the kinds of person who (considering for the moment only sentences of imprisonment) are sent to prison for the first time. Thus, if it became unusual to send anyone to prison until he was already a hardened criminal, a low success rate would be looked for (though it would be unsafe to rely on a high success rate if courts went to the opposite extreme). Similarly, the success rates for Borstal training, corrective training and preventive detention will not necessarily be comparable with each other, or with those for prison sentences, because the persons receiving the different sentences are likely to fall into different classes so far as their previous criminal history and other characteristics are concerned.

47. Important as it is to know what success a particular kind of sentence, such as one of imprisonment, has in reforming or deterring those offenders who receive it to the extent that they do not return to prison on conviction, this is plainly only a small fraction of the information needed if the courts are to have adequate statistical data for their guidance in passing sentence. The question requiring an answer is itself doubtful because of the wide variety of offenders and the different views on punishment which can be held; but one way of putting it, at least, is: given

* Persons in prison following conviction of certain offences may have their finger-prints taken. These offences are sometimes referred to as "finger-printable offences"; they include most indictable offences and the more serious non-indictable offences.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

an offender who can be classified in a certain class, what kind of treatment is most likely to turn him into a useful citizen who will not commit further crime? This question ignores the merely preventive aspect of imprisonment, and may therefore need modifying before being applied to habitual criminals. In attempting to answer it, the two main problems are (*a*) to work out a system of classifying offenders which will permit the selection of similar groups who are sentenced to different forms of treatment, and (*b*) to obtain a standardized criterion for the success of treatment. Work has been done and is continuing, in the United States of America and in this country, on the classification of persons undergoing particular forms of treatment in relation to their success or failure, and the technique is being learnt for the selection of the comparable groups needed. Different criteria of success have been used, in particular the absence of recorded reconvictions, which has the merit of simplicity to set off against its many shortcomings.

48. The subject of research into the results of treatment has an immediate bearing on the records which should be kept of persons coming before the courts. If a standard system of classifying offenders as a help in deciding on treatment is ever worked out, the information necessary for such classification must be available before sentence is finally passed; and until a classification is standardized even fuller information must be obtained. Fortunately, a good deal of information is already collected under the present procedure, though not so far under standard headings.

SCOTTISH CRIMINAL STATISTICS

49. The criminal statistics of Scotland are based on different legal, judicial and police systems from those of England and Wales, and they are compiled quite independently in Edinburgh. It is therefore inevitable that there should be deep-rooted differences between the two sets of statistics. There is, however, enough similarity to make approximate comparison possible and, at the suggestion of the Interdepartmental Committee on Social and Economic Research, the Home Office and the Scottish Home Department with the assistance of the Central Statistical Office are working together to construct a basis on which the figures can be compared. The results of this work will no doubt be published and no attempt can be made here to anticipate them; it would in any case be impossible to discuss the subject adequately in an article of this kind. Some general remarks are made below, however, on the bases of the Scottish statistics.

50. Notes on criminal procedure in Scotland and on the terms used in the tables are contained in *Criminal Statistics* (*Scotland*). So far as the number of offences known to the police is concerned, there is no reason to believe that the practice in Scotland is materially different from that of England and Wales, which itself varies between different police forces. There are, however, complications, mentioned briefly below, which make comparisons on this basis impossible except for a few types of offence. The statistics of court proceedings are constructed similarly to those of England and Wales in that they show the number of persons dealt with, ignoring additional convictions and offences taken into consideration, and count a person once for every occasion on which he is proceeded against; they therefore offer a valid basis for comparison. Some points which must be taken into account follow:

(i) In Scotland there are 37 classification groups of crimes; these cover broadly, but not closely enough to permit accurate comparison, the same ground as the 70 groups of indictable offences in England and Wales. Other offences, including offences against war legislation, are known as miscellaneous offences and comprised in classification groups numbered 38 to 95; they correspond roughly to non-indictable offences and offences against defence regulations in England and Wales.

(ii) Not only crimes, but also miscellaneous offences made known to the police are recorded in Scotland.

(iii) The number of crimes of murder recorded is in Scotland the number of complete incidents of murder, irrespective of the number of people killed. In the statistics for England and Wales this would be referred to, if at all, as the number of "cases" of murder, and the number of offences recorded as known to the police is the number of persons murdered. There may perhaps be similar discrepancies arising out of the practice of the police in dealing with other kinds of offence, such as multiple frauds.

(iv) In Scotland the description of a crime in the table of crimes made known to the police is amended to agree with the nature of the crime as judicially determined if the case is determined

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

within the year. Such an adjustment is not now made in England and Wales (except for murders), though it was up to and including 1949 for all offences against the person. It is fairly common to make alternative charges when some kinds of offence are committed (e.g., felonious or malicious wounding), and for the offender to be convicted only of the less serious offence. The Scottish recording practice may therefore cause some of the more serious offences to appear relatively less numerous than would the method used in England and Wales.

(v) In order to obtain comparable groups of offences it is often necessary to set a combination of several offences from the statistics of England and Wales against one Scottish crime or offence. It may be necessary to include non-indictable offences with indictable offences to form a group comparable with a Scottish group. In England and Wales only indictable offences are recorded as known to the police; consequently it is not in general possible to compare the two sets of statistics of crimes known to the police. For some particular offences (e.g., bigamy, perjury) it is, however, possible to do so at once, and when the correct grouping of offences is known many further comparisons can be made, subject to the objections mentioned in (iii) and (iv) above.

(vi) When comparing the tables of court proceedings it is necessary to be careful in selecting methods of disposal which are comparable. The numbers of persons proceeded against are probably fairly comparable, but there are differences in procedure which make it difficult to be certain about this. The numbers of persons found guilty are not comparable, because in Scotland certain orders are made without a finding of guilt which in England and Wales go with a finding of guilt. Probably the best unit of comparison is the number of persons against whom charges are proved; though it may be better to include also on the Scottish side the number of persons who forfeit their pledges, on the grounds that the corresponding people in England or Wales would be dealt with by the court and would mostly be found guilty and fined.

Bibliography

Only a few works other than official publications are mentioned, but several of them contain bibliographies or footnote references. There is a large body of American writing which cannot be adequately noticed, and periodicals dealing with criminology, penology, sociology and psychiatry in both Great Britain and the U.S.A. frequently contain articles with a bearing on criminal statistics.

Official Publications

Annual Abstract of Statistics. London: H.M.S.O.

Criminal Statistics, England and Wales. London: H.M.S.O. (Annual.)

Criminal Statistics, Scotland. Edinburgh: H.M.S.O. (Annual.)

Report on the Administration of Home Office Services (*Northern Ireland*). Belfast: H.M.S.O. (Annual.

Supplementary Statistics relating to Crime and Criminal Proceedings (*England and Wales*). (Not published but supplied annually by the Home Office on request.)

Report of the Commissioners of Prisons. London: H.M.S.O. (Annual.)

Report on Prisons in Scotland. Edinburgh: H.M.S.O. (Annual.)

Sixth Report on the Work of the Children's Department (1951). London: H.M.S.O. (Also see earlier reports; published irregularly.)

Report of the Departmental Committee on Detective Work and Procedure (1938), **1, 3**. London: H.M.S.O.

Report of H.M. Inspectors of Constabulary. London: H.M.S.O. (Annual.)

Report of H.M. Inspector of Constabulary for Scotland. Edinburgh: H.M.S.O. (Annual.)

Report of the Commissioner of Police of the Metropolis. London: H.M.S.O. (Annual.)

Offences of Drunkenness, 1950 (*Cmd.* 8427). London: H.M.S.O.

Offences Relating to Motor Vehicles. London: H.M.S.O. (Annual.)

Other Publications

BURT, C. (1925), *The Young Delinquent.* University of London Press. (Contains a bibliography and references.)

GLUECK, S. and E. (1950), *Unravelling Juvenile Delinquency.* New York: Commonwealth Fund. (Also see the bibliography to Grünhut (1951) for the Gluecks' earlier works.)

GRÜNHUT, M. (1951), *J. Roy. Statist. Soc.*, A, **114**, 139. (Contains a bibliography.)

HORST, P., *et al.* (1941) *The Prediction of Personal Adjustment.* New York: Social Science Research Council.

MANNHEIM, H. (1940), *Social Aspects of Crime in England.* London: Allen & Unwin.

MORRIS, N. (1951), *The Habitual Criminal.* London: Longmans. (Bibliography of follow-up studies, page 376.)

RADZINOWICZ, L. (1945), *A Modern Approach to Criminal Law*, 174. London: Macmillan.

REISS, A. J., Jr. (1951), *American Journal of Sociology*, **42**, No. 2, 115. (A critical article on Glueck (1950).)

SELLIN, T. (1951), *Law Quarterly Review*, **67**, 489.

SILCOCK, H. (1949), *The Increase in Crimes of Theft*, 1938-1947. University Press of Liverpool.

The British Journal of Delinquency. London: Institute for the Study and Treatment of Delinquency *and* Baillière, Tindall & Cox, Ltd. (Quarterly.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

Timber Statistics

By J. J. MacGregor

Department of Forestry, Imperial Forestry Institute, University of Oxford

Contents

	Page
I. Introduction	298
II. Resources of Home-Grown Timber and Current Policy Aims	
(*a*) Area and Volume of Production and Standing Timber	300
(*b*) Measurement of Home-grown Timber Production	300
(1) Woodland Censuses of 1930 and Earlier Years	300
(2) The Census of 1938–1939	301
(3) The Woodland Census of 1942	302
(4) The Woodland Census of 1947–1949	302
(5) The Hedgerow Census of 1951	304
(*c*) Yield and Volume Tables	304
(*d*) Sampling Techniques	304
III. Supplies	
(*a*) Imported	305
(*b*) Home-Grown and its Proportion of Total Supplies	305
IV. Prices	
(*a*) Imported	310
(*b*) Home-Grown	310
(*c*) Net Income of British Forestry	311
V. Supplies and Prices of Imported, and Supplies of Home-Produced Timber Products	
(*a*) Plywood	313
(*b*) Fibre Building Boards	313
(*c*) Pulp and Paper	314
VI. Stocks of Timber and of Timber Products	315
VII. Consumption	
(*a*) Softwoods	317
(*b*) Pitwood	317
(*c*) Hardwood	318
(*d*) Plywood and Veneers	318
(*e*) Fibre Building Boards	319
(*f*) Paper and Pulp	319
VIII. Miscellaneous and General Sources of Timber Statistics	319

I. Introduction

Timber statistics for the United Kingdom are available from many separate sources and appear in many different forms. Unfortunately there are few sources of comparable data which can provide suitable information on trends, although in this respect the twentieth century has seen considerable improvement. Unfortunately, too, the industry is bedevilled with a variety of units of measurement which are not always capable of being strictly and accurately translated into other standards.

The timber supplies of the United Kingdom are in very large measure obtained from overseas and this outstanding reliance is perhaps one of the most striking things about the British timber

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

situation and policy. In the period between the two world wars about 96 per cent. of total requirements were regularly imported and all but 6 per cent. of total consumption was of softwoods. From time to time changes have been made in the published statistics to show the information for more categories. From 1934 it is possible to show from the Trade and Navigation Accounts the volume and value of a dozen major import categories. This has, however, led to the criticism that whereas the pattern of the trade statistics has remained the same since then the pattern of the trade has greatly changed, and more details are required from the statistical summaries. Changes are, however, likely to be made in the presentation of the data so that changing patterns of trade may be properly recorded.

The statistics of home produced timber have been unsatisfactory for many purposes. One reason is that the home production of timber is derived as a kind of by-product from the highly individualistic forms of woodland ownership associated with private estates. Before 1919 there was no national forest policy for Britain, although in the previous half-century or so forestry had been the subject of Royal Commissions and various other committees, and associated with periods of investigation in the twentieth century a start was made on a series of woodland censuses. With the national policy which directly emerged from war-time difficulties and shortages, came the introduction of State forestry and the encouragement of private woodlands.

Many aspects of private and State forestry have been recorded in the Annual Reports of the Forestry Commission—in line with the provision in the 1919 Forestry Act, which set up the Forestry Commission, that it should undertake the collection, preparation and publication of statistics relating to forestry. The areas planted and acquired, the area and number of estates acquired, employment, the number of workers' holdings established, financial details of operations (expenditure and income) and species planted, are among some of the regular items which are broken down in fair detail. It has been a practice to give more descriptive information in every fifth report and to review more fully the general progress made to date. Many general statistics relating to forestry in the United Kingdom, and occasionally to comparisons with other countries, appeared in the *Post-War Policy Report* published in 1943 (33). Apart from the summaries of the previous annual data this *Policy Report* is chiefly useful for drawing attention to some statistical aspects as rates of production of timber in Great Britain compared with certain continental countries, displacement by afforestation of sheep stocks and loss of meat and wool production, estimated cost of proposals, forest areas by countries and the percentage of total are covered by forestry.

II. Resources of Home-grown Timber and Current Policy Aims

Apart from a minor contribution from the Crown Lands, the home production of timber in the past was obtained from private woodlands. In general, timber production on private estates was viewed less as a commercial enterprise than as an adjunct to sport and amenity. Its significance in the economy of most rural estates was relatively slight in relation to the income from farming rents, a fact which could be partially inferred from the very small proportion—about the lowest in Europe—of the land devoted to forestry. This attitude and situation, combined with the fact that on most private properties a good deal of the available production of timber was used in estate maintenance, meant that any statistical measurements of the national production were likely to be far from accurate. Attempts had, however, been made in 1871, 1887, 1895, 1905, 1908 and 1913 to make some measure of forestry area and production.

The passing of the Forestry Act of 1919 established a Forestry Commission to develop State forestry and to encourage and give advice on private forestry. The experience of an island nation in the siege warfare of 1914–1918 had strengthened the desire of the Government not only to make more effective use of the existing woodlands but to expand the area devoted to the production of a bulky commodity like timber. This, in turn, implied that the State forestry would have to be integrated with private forestry. Attempts were therefore made to measure more precisely the quantity and quality of the country's woodlands as a whole. Censuses of woodlands were made in 1924, in 1930, in 1939, during World War II, and again in 1947.

At the outbreak of World War II a Home-Grown Timber Production Department was set up and, with a very strict timber control, it was possible to have a fairly accurate assessment of the home output.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(a) *Area and Volume of Production and Standing Timber*

Although the bases and classifications of the earlier censuses varied, there is a fair degree of agreement that the total woodland area in Great Britain varied between 2¾ and 3 million acres. By 1938, as a result of the expansion of State forestry, the area is shown as exceeding 3 million acres.

Statistics for 1905 were collected by the Board of Agriculture, and again in 1913 for England and Wales and in 1914 for Scotland (1, 2, 3). In these surveys, schedules asking for data on (*a*) coppice including coppice with standards ; (*b*) plantations under 10 years old and (*c*) other woods, were distributed by local officers of the Board of Customs and Excise to owners of woodland. In 1918 a more detailed survey than that of 1914 was begun and completed in a year in Scotland by the Timber Supply Department to determine the supply of timber for war needs. The corresponding survey in England was not completed and estimates appear to have been based on the part of the survey which was completed. The more comprehensive survey of 1924 explains (18) that the apparent increase in area was due chiefly to more intensive methods of surveying and to the inclusion of "scrub". Less than half (47·9 per cent.) of the total area, or 1,416,890 acres, was described as "high forest". For conifers the age classes were regarded as fairly well balanced, and thus "there should be forthcoming a small but steady supply of softwood timber". As afforestation schemes and re-afforestation were continued the youngest age classes would gradually predominate, but these would have little immediate effect on increasing annual supplies or reserves of timber.

With hardwoods it was otherwise, for the age classes were out of balance. Little planting had been done for a generation or more, and the bulk of the hardwoods—and of the mixed plantations—were mature or semi-mature. This implied that the existing supplies of hardwood could be maintained for some time but, with the small amount of replanting, it was inevitable that the home output would become insignificant.

In the forty years before the 1924 census the average rate of hardwood and softwood planting was about 12,000 acres per annum, and in the previous 40 years it was nearly 16,000 on the plantations still surviving in 1924. Thus the original plantings must have been considerably larger in view of the clear felling which had occurred during the war. It appears that the high rate of planting associated with the end of the Napoleonic War gradually slowed down during the nineteenth century, to increase a little again in the first decade of the twentieth century. With the falling-off in planting there has been a clear substitution of hardwoods by softwoods. The average rate of planting since 1884 was regarded in the 1924 Census as being only about half of the rate required to keep the normal area of the woodlands in a good state of productivity. At the time of the Census 91·9, 1·4 and 6·7 per cent. of the woodland area belonged to private owners, to corporate bodies and to the State respectively.

For some purposes it is rather unfortunate that none of the censuses provide information about the size of the woodlands in individual ownership. A very broad indication for 1923 was obtained through the Chief Valuer of the Department of Inland Revenue by W. E. Hiley (61). This showed that in England and Wales there were (*a*) 4 estates with more than 5,000 acres ; (*b*) 9 with 3,000–5,000 acres, and (*c*) 174 with 1,000–3,000 acres. From these data it was deduced that the 187 estates must have had about 400,000 acres altogether, which meant that about 1,400,000 acres of woodland were owned in units of less than 1,000 acres. It is clear that the industry is very largely made up of relatively small enterprises, although these may often be associated with relatively large rural estates.

(b). *Measurement of Home-Grown Timber Production*

(1) *Woodland Censuses of* 1930 *and Earlier Years*

Censuses of home-grown timber production were carried out in 1908 and 1913 by the Board of Agriculture, but the outbreak of hostilities prevented completion of the latter. The 1924 Census report criticized the procedure of sending out forms to all the woodland owners. This was regarded as unsatisfactory, since a large proportion of the forms were either not returned or were incomplete. Accordingly the 1924 Census adopted a sampling basis in which the individual returns of selected owners were related closely to the relevant types of woodlands. It is clear

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

that the estimates for 1908 of the volume of timber felled annually are far too low compared with later estimates and this justifies the criticism made in the 1924 report.

The report of the Acland Sub-committee (38) estimated that just before the 1914 war the annual fellings amounted to 45 million cubic feet—an amount which was less than 15 cubic feet per acre per annum for the nominal woodland area. Although this represented a low productivity, it was the opinion of the Sub-Committee that the annual increment was even lower, so that a decreased yield could be expected with the passing of time (Tables 1 and 2 below). It is of some special interest that this Sub-Committee, whose recommendations were to lay the foundation of the national forest policy, drew attention to the greater productivity of State forests compared with private forests in Germany. On the German evidence, but allowing for the fact that fuelwood played a greater part in the German economy, it was estimated that the United Kingdom would require about 16,000,000 acres of woodlands to be completely self-supporting for customary needs. Remembering that the more recent policy of expanding the forest area to 5,000,000 acres is intended only to cover about 35 per cent. of total requirements, and that Eire is no longer included in the United Kingdom, the Acland estimate appears to have been supported by later experience.

In 1930 a more simple but supplementary survey (19) to the 1924 Census was undertaken by the Forestry Commission, as a parallel inquiry to that conducted by the Board of Trade for their Census of Industrial Production for 1930. It was again based on a sample, but did not attempt to relate the production to the types of woodland which were not re-surveyed. Expressing the data as standing timber, to make a fair comparison and excluding the imports of manufactured wooden commodities, home production was in 1924 and 1930 respectively 5·4 and 4·4 per cent. of total requirements.

In the report on the 1924 Census (18) the following approximation was compiled—based on estimates of current annual increment of each type of woodland and age class—to show the increment in relation to annual cut.

TABLE 1

Home Production Compared with Increment, 1924

	Production		*Increment*	
	Million cu. ft.	*Cu. ft. per Acre*	*Million cu. ft.*	*Cu. ft. per Acre*
High Forest—				
Conifers	27·6	33·5	26·0	31·6
Hardwoods	15·8	26·6	11 5	19 4
Coppice, coppice-with-standards and "uneconomic"	10·0	13·6	6·1	8·3
Other types of woodland	2·6	3·2	—	—
Total	56·0	18·9	43·6	14·7

(2) *The Census of* 1938–1939

Although there had been little evidence of change in the general character of woodlands since the 1924 Census, it was decided when war threatened Europe that a fresh and more detailed census was desirable for the needs of war-time planning. Accordingly, the Forestry Commission, in consultation with the National Home-Grown Timber Council, started a survey in 1938 on all woodlands over 5 acres. When in fact hostilities broke out the survey was only partially complete, and it was decided to give up the original idea and arrive at a general result by sampling. The decision to follow the sampling method was criticized by Meiggs (75) as the later work of the Divisional Officers, especially in planning their acquisitions, would have been greatly eased if they could have consulted a complete Census. The total estimate of standing timber was 2,800 million cubic feet, equally divided between softwoods and hardwoods. It was thus established early in the war—and proved later—that there would be no serious shortage of hardwoods as a whole; that the reserves of softwoods were likely to have very serious inroads made into them, and that, above all, the critical shortage would be in pitwood.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(3) *The Woodland Census of* 1942

In 1942, when it was obvious that the end of the war was not yet in sight, another Census became necessary to assist in the acquisition and long-term planning policy. The 1942 Census was complete for Scotland, and made on a 10 per cent. sample for England and Wales. The estimated total of standing timber in June, 1942, was 1,838 million cubic feet, of which 60 per cent. was hardwood. Although the 1942 Census, even allowing for the intervening heavy felling, gave a conservative estimate of the supplies, it confirmed the general picture about the different categories of timber.

(4) *The Woodland Census of* 1947–1949

The Census of 1947–1949 had two main objectives: (1) to map and classify all woodlands in blocks of five acres and over, and (2) to estimate the timber volume and increment of the existing woods in order to regulate future fellings (20). Of the coniferous high forest area of nearly 950,000 acres, 76 per cent. was under 40 years of age. The Forestry Commission areas were 62 per cent. of the younger class of 1–40 years and 50 per cent. of the total areas. Of the total broadleaved high forest area of nearly 850,000 acres only 11 per cent. was under 40 years. Of the broadleaved species the Forestry Commission areas were 30 per cent. of the younger age class and 8 per cent. of the total area.

Attention was drawn by the Census data to the standing volume and to the annual growth, and it was contended that by restoring the unproductive areas and by intensive management of the whole existing area, excluding new afforestation, both the standing volume and the annual increment could be nearly trebled.

The relevant data on existing standing volumes are shown in Table 2, while Table 4 shows the recent growth of the forest areas in the United Kingdom and also some detailed information about the Forestry Commission estates.

TABLE 2

Standing Volume and Increment Based on the Census of 1947–1949

	Millions of Hoppus Feet over Bark	
	Coniferous	*Broadleaved*
Standing volume	1,115	1,544
Annual increment	68	29
Increment as a percentage of volume . .	6·1	1·5

On the basis of the 1947–1949 Census records of the existing conditions and with due allowance for new planting on the scale proposed in the Report on Post-War Policy (33), allowances for clear felling and wastage due to fire and so on, the following estimate (Table 3) of volume and production for the period 1960 to 1980 has been made by the Forestry Commission.

TABLE 3

Estimates of Volume and Production, Great Britain, 1960–1980

Year		*Area* (000 *acres*)	*Millions of Cubic Feet Hoppus Measure over Bark*	
			Volume Standing	*Annual Increment*
1950	Conifers	945	1,115	68
	Broadleaved	1,074	1,544	29
1960	Conifers	1,630	1,510	86
	Broadleaved	1,150	1,503	29
1970	Conifers	2,770	2,280	145
	Broadleaved	1,290	1,480	32
1980	Conifers	3,260	3,680	260
	Broadleaved	1,320	1,520	39

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 4

Forest Area of the United Kingdom, 1937–1949

(*Thousand Acres*)

	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
Forest Area													
United Kingdom	3,072	3,093	3,116	3,140	3,159	3,173	3,183	3,188	3,191	3,197	3,214	3,238	—
Great Britain	3,025	3,045	3,067	3,089	3,108	3,121	3,131	3,136	3,139	3,145	3,162	3,186	—
Northern Ireland	47	48	49	51	51	52	52	52	52	52	52	52	—
Forestry Commission (i)													
Total Estates	1,006	1,097	1,144	1,212	1,227	1,237	1,253	1,270	1,364	1,415	1,441	1,477	1,560
Land under Plantation	377	403	434	451	472	485	493	494	498	507	534	569	586
Plantable Land acquired during year	42·3	64·1	32·2	31·6	12·5	8·2	12·4	10·3	43·3	33·2	20·8	29·0	51·0
Total area planted (ii)	20·1	24·1	28·2	27·3	26·9	16·7	13·4	9·2	6·5	10·4	26·4	36·4	43·9
Area lost by Fire	0·2	2·0	1·0	1·8	3·0	6·5	1·0	1·9	0·3	1·1	0·6	1·8	0·5

Sources: Forestry Commission, in Statistical Abstract.

(i) Figures relate to Great Britain only and are for years ending September 30th.
(ii) Including replanting after damage by fire.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(5) *The Hedgerow Census of* 1951

The Report (22) on the Census of Hedgerow and Park Timber and Woods under Five Acres gives the methods which were based, with appropriate modifications, on the incomplete surveys of 1939 and 1942. It gives the methods used; the results of the survey; the estimated volume of timber standing in hedgerows; small woods and "the unproductive" areas of larger woods in Great Britain. The survey was carried out on a sampling basis. The volumes of all trees estimated in the Census of 1947–49 and of 1951 are measured in Table 5.

TABLE 5

Volume of Timber in Trees and Woods of all Descriptions—Great Britain

Millions of Cubic Feet, Quarter Girth, Over Bark

Description	*Coniferous*		*Broadleaved*		*Total*	
	Volume	*Per cent.*	*Volume*	*Per cent.*	*Volume*	*Per cent.*
Hedgerow and park trees . . .	58·6	5	748·1	30	806·7	21
Small woods of 1–5 acres						
Productive areas (except coppice) .	53·6	4	164·0	7	217·6	6
Unproductive areas (plus coppice) .	1·0	—	3·9	—	4·9	—
Total, small woods . . .	54·6	4	167·9	7	222·5	6
Large woods, 5 acres and over						
Productive areas (except coppice) .	1,143·9	90	1,514·5	60	2,658·4	71
Unproductive areas (plus coppice) .	14·5	1	71·1	3	85·6	2
Total, large woods . . .	1,158·4	91	1,585·6	63	2,744·0	73
Grand total, all descriptions .	1,271·6	100	2,501·6	100	3,773·2	100

Source: Forestry Commission Census Reports.

(c) *Yield and Volume Tables*

Although some attempts were made before the Forestry Commission came into existence to prepare yield and volume tables for individual species of trees in Britain, notably by P. T. Maw (73, 74), the Forestry Commission has been largely responsible for research into this aspect, and has published data based largely on their permanent sample plots distributed throughout the country. In 1928 complete yield tables based on temporary sample plots on private estates (1914–18) were published for European Larch, Scots and Corsican Pine, Norway Spruce and Douglas Fir, and preliminary tables for Japanese Larch and Sitka Spruce (23). More recently volume tables, prepared by the Forestry Commission mensuration staff, have been published as a series of forestry records which give average hoppus feet volume for a range of breast-height, quarter-girth by quarter-inches and total heights of timber separately for conifers and broadleaved species (24–32). The volume tables are intended to assist foresters to estimate the cubic content of standing timber. Their use has, however, to be qualified because the data give average volumes which are not precise for individual trees, but give reliable general totals for areas or stands. The records give suggestions about sampling, and indicate the margins of error which are to be expected. The records were prepared in order to assist in the estimation of volume in connection with the Census of Woodlands. Fairly full information about the preparation of the tables in the records is to be seen in the report on forestry research for the year ending March 1949, in a chapter headed "Studies in Growth" (17).

(d) *Sampling Techniques*

It is appropriate here to draw attention to sampling techniques used with forestry data. Starting in 1947 Dr. D. J. Finney has prepared several articles which have appeared in *Forestry*, covering aspects of sampling of forestry data (54–57). Two of these papers have references to nearly thirty different papers on sampling theory and technique in forestry. The articles refer mainly to standing timber.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

III. Supplies

(a) *Imported*

During the last century or so the outstanding feature of the United Kingdom timber requirements is the very heavy reliance on imports. For this reason the changing pattern of timber consumption could fairly adequately be studied from import data alone, especially as these were classified more and more. Export volumes were relatively small. The structure, special problems, conditions, developments, and many other aspects of the fairly complex pattern of the timber trade in the United Kingdom have recently been the subject of a special study, which is an essential background for a full understanding and interpretation of many of the statistics of timber supply (71). The special function of timber control and its relation to the general trade structure during and since the Second World War was the subject of a very comprehensive report (41).

Timber imports have been classified in the Trade and Navigation Accounts since 1843, and from then it is possible to show broadly the relative proportions of round and sawnwood; hardwoods and softwoods were shown separately from 1891, and mining timber from 1901, sleepers from 1914, planed and dressed from 1915, and plywood from 1925. Since 1935 more detail is shown in the classification and, apart from the relatively minor category "other worts", twelve categories are distinguished (see Table 6). Two of the timber categories, "hewn" and "sawn and split" wood, have been used in the Sauerbeck and in the Sauerbeck-Statist Index, which is now published each year in the *Journal of the Royal Statistical Society*.

The Post-War Policy Report of the Forestry Commissioners (33) has a table which summarizes the trend of imports, quantities and value, from 1843 and with an extended list of categories from 1909. The data show that over these 70 years imports increased at a faster rate than the population; the consumption per head—with due allowance for home production—is probably a very good indication of the increase in the general national standard of living and industrial activity. In 1851 the imports were 3·5 cubic feet per head and in 1911, 10·5 cubic feet per head. Not only has there been a quantitative but a qualitative change in these imports; whereas in 1843, 46 per cent. of total imports (excluding staves) were sawn, in 1866 the proportion had risen to 69 per cent. Hiley, who noted this relationship (59) from the trade statistics, also observed that up to 1928 the large volume of hewn wood which was still imported was chiefly used for pitwood. Pitwood in 1901 was 68 per cent. of all hewn coniferous imports, and in 1927 had risen to 93 per cent. From this situation he inferred that the proportion of hewn to sawn imports was mainly determined by the respective demands of the mining and of the construction industries.

Imports of softwoods were at a very high level in 1937 and the level from 1933 to 1938 was particularly high, exceeding that at the beginning of the century. Hardwood supplies before World War II were also at a high level not previously attained in the twentieth century. The fluctuations in supplies, as measured by imports, bore a close relationship to house building and other activities, to the betterment of the terms of trade in this period, and to the increased rate of rearmament. Apart from the periods influenced by the war years, the data indicate that the consumption per head was equivalent to approximately 18–20 cubic feet of standing timber. Since the second world war the level had risen to about 14 in 1951 after being about half of the pre-war level. The trends for plywood, pulp and paper imports show the same tendency to increase steadily up to the period before World War II. The volume of certain categories of these net imports should be considered in relation to available measures of such developments as house building, output from mines and general business activity.

The trend of the volume of the main categories of timber imports available in the Trade and Navigation Returns is shown as a series of indices—with 1938 as 100—in Table 6 (69). To correct to some extent the exaggerated effect of the more usual measures for piled round timber "standards" "piled cubic fathoms" have been reckoned, where applicable—as for pitwood, hewn soft, hewn hard, and telegraph poles—to 99 and 151 cubit feet respectively.

(b) *Home-Grown and its Proportion of Total Supplies*

Although there are no continuous records of the volume of standing timber felled annually in Britain, Hiley remarked that it was generally estimated at from 40–50 million cubic feet, or about 15 cubic feet per acre per annum—figures which were also used by the Acland Committee (38). The annual cut in Britain is put at 50 million cubic feet until the first world war, 140, 100

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 6

*Timber Imported in Categories by Index Numbers, 1938=100**

	Sawn Soft	*Sawn Hard*	*Pit-wood*	*Planed Dressed Soft*	*Sleep-ers*	*Box Boards*	*Hewn Soft***	*Hewn Hard*	*Ven-eers*	*Planed Dressed Hard*	*Staves*	*Tele-graph Poles*	*Total Im-ports†*	*Some Sawn Hard Species‡*			
														Maho-gany	*Teak*	*Oak*	*Wal-nut*
								Unit Value									
Value per cu. ft.																	
1938	19·4*d.*	44·5*d.*	10·9*d.*	22·4*d.*	24·5*d.*	29·6*d.*	12·7*d.*	42·5*d.*	28·4*d.*	38·1*d.*	65·0*d.*	42·2*d.*	20·8*d.*	70·0*d.*	108*d.*	48·0*d.*	95·5*d.*
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1952	654	449	632	659	572	627	548	313	289	674	611	626	553	296	538	475	—
1951	654	400	520	574	477	582	525	332	257	443	581	400	596	314	552	433	—
1950	408	297	294	443	319	365	286	252	255	504	512	332	399	218	381	348	—
1945–9	359	271	330	364	321	353	405	195	184	484	360	286	323	208	293	275	131
1940–4	274	184	232	240	213	267	267	155	115	207	279	212	286	141	108	194	86
1935–9	96	98	90	98	80	91	76	100	103	97	79	102	95	102	89	97	94
1930–4	85	98	86	87	62	80	85	102	96	92	49	54	85	101	97	96	109
1925–9	115	138	103	—	84	—	137	121	97	—	53	—	113	125	112	124	135
1920–4	172	208	145	—	139	—	261	205	80	—	111	—	140	179	150	193	130
1915–9	232	—	210	—	151	—	355	—	—	—	98	—	215	—	—	—	—
1914	78	—	73	—	51	—	109	—	—	—	44	—	77	—	—	—	—
Average 1909–13	—	—	75	—	—	—	—	—	—	—	36	—	68	—	—	—	—
								Total Volume									
Volume§ '000 c.f.																	
1938	244,275	30,747	103,392	49,149	19,340	14,625	17,926	4,218	617	3,699	1,996	2,218	494,281	849	1,844	9,198	228
Year																	
1952	67	79	104	3	15	35	112	289	192	5	24	56	69	126	24	38	
1951	107	125	63	9	66	42	84	505	343	8	46	42	92	117	45	65	
1950	51	135	53	5	49	33	71	368	208	3	41	102	55	118	36	66	
1945–9	59	53	69	17	43	29	89	237	166	3	30	63	57	54	33	41	4
1940–4	32	38	15	17	24	20	13	105	219	8	21	3	27	73	62	23	17
1935–9	115	116	105	105	85	97	79	92	103	107	105	91	109	17	119	124	131
1930–4	102	94	73	87	84	71	83	89	62	85	134	79	71	92	67	122	119
1925–9	104	95	89	—	80	—	76	162	29	—	277	—	93	195	110	117	224
1920–4	81	51	87	—	78	—	46	126	13	—	247	—	75	117	75	58	136
1915–9	60	—	24	—	31	—	14	—	—	—	172	—	48	—	—	—	—
1914	83	—	8	—	56	—	70	—	—	—	232	—	77	—	—	—	—
Average 1909–13	—	—	10	—	—	—	—	—	—	—	402	—	93	—	—	—	—

* Based on Trade and Navigation Accounts. See also Refs. 69 and 70.
** Includes Roundwood logs.
† Includes in addition to the data of columns 1–12, a very small quantity of "other sorts".
‡ The four species are included along with "other sorts" of sawn hardwood in column 2.
§ The volumes for roundwood categories such as pitprops, hewn soft, hewn hard and telegraph poles are estimated by reckoning standards and piled cubic fathoms at 99 and 151 cu. ft. respectively.

Note.—The index number for the five-year periods is based on the average of the index numbers for the individual years.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar
Digitized by Arya Samaj Foundation Chennai and eGangotri

Note.—The index number for the five-year periods is based on the average of the index numbers for the individual years.

TABLE 7

Indices of Home-Grown Timber Prices, 1914–1952. 1938 = 100*

Year	Prices of 4 Categories of a Standard Product[1]					Prices of Pitwood Delivered to South Wales[2]				Seven Previous Categories of Selected Timber Products[3]	Railway Sleepers Produced in Scotland[4] Nett. F.O.R.	Eight Categories of Selected Timber Products[5]	Prices of Pitprops Delivered in Scotland[6]	
	A	B	C	D	Combined	Larch	Other Conifer	Hard Woods	Combined				3″ Rd. Props	Crowntrees 6″×6″×3″
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1914	55	64	65	66	63	77	65	65	69	65	70	66	50	80
1915–9	98	110	129	115	116	166	151	152	156	129	146	131	231	320
1920–4	109	112	122	132	127	166	157	156	159	139	132	138	—	—
1925–9	79	87	77	79	79	112	112	109	111	94	100	95	—	—
1930–4	72	76	77	78	76	97	97	96	97	69	95	70	59	85
1935–9	89	93	95	96	94	95	95	95	95	94	100	95	113	185
1940–4	135	124	128	129	130	191	170	182	181	149	179	152	127	330
1945–9	158	156	148	148	152	238	211	220	223	181	257	190	166	360
1950	211	228	222	222	221	270	238	245	251	234	390	253	—	—
1951	261	273	285	264	271	270	238	245	251	262	445	285	—	—
1952	—	—	—	—	—	**	**	**			510			

* Source: Refs. 67 and 70.
** Not comparable.
[1] Delivered prices.
[2] Fresh felled, unpeeled, delivered prices.
[3] Column 10 includes combined unweighted average of prices used in column 1–4 and 6–8.
[4] Softwood (mainly Scots Pine). An appropriate allowance is made for reduction in length of sleeper from 9 ft. to 8½ ft. from 1921 onwards. The other specification (10 in. by 5 in.) remained unaltered.
[5] Column 12 includes data used in calculation of column 10 with the addition of data used for column 11.
[6] Unpeeled, delivered prices except for 1947, which include carriage cost up to 10*s*. per ton, any excess being paid by buyers.
Note.—The Index Number for the five-year periods is based on the average of the index numbers for the individual years.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar
Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 8

Home Production and Imported Supplies, 1935–9 and 1940–9

Year	*Softwoods ('000 Standards)*				*Hardwoods (Million Cubic Feet)*				*Pitwood ('000 Standards)*			
	Home Production	*Consumed Imports*	*Total*	*Home-Grown %*	*Home Production*	*Consumed Imports*	*Total*	*Home-Grown %*	*Home Production*	*Total Imports—** Pitwood '000 Standards (Gothenburg)*		*Home-Grown %*
1935–9	113 (i)	2,148	2,261	5·0	12·35 (i)	44·12	56·47	21·9	39 (i)	972		4·2
1940	177	709	886	13·2	22·3	25·5	47·8	46·5	597	(136)*	433	59·0
1941	280	630	910	30·8	29·5	19·3	48·8	60·4	574	(169)	75	88·4
1942	298	478	776	38·4	41·4	16·3	57·7	71·5	637	(191)	11	98·2
1943	288	430	718	40·0	50·8	13·2	64·0	79·3	721	(195)	28	96·1
1944	196	605	801	24·5	47·0	11·2	58·2	80·6	602	(205)	74	88·9
1945	130	752	882	14·7	41·2	16·9	58·1	70·7	504	(184)	193	72·2
1946	88	988	1,076	8·2	38·0	19·0	57·0	66·6	338	(135)	552	38·0
1947	67	911	978	6·8	37·3	19·9	57·2	65·2	165	(81)	773	17·4
1948	65	1,046	1,111	5·9	40·8	21·6	62·4	65·5	195	(103)	652	28·0
1949	65	1,087	1,152	5·6	41·6	30·6	72·2	57·6	193	(105)*	670	27·4
1950	53	973	1,026	5·5	37·4	59·5	96·9	38·5	177	—	438	23·0
1951	47	1,096	1,142	5·0	34·0	59·6	93·6	36·5	161	—	500	20·0

(i) Forestry Commission Census 1930 as there was no record of home production in the immediate pre-war years.

* This column shows the proportion of "sawn pitwood".

Source: Board of Trade.

** Import data for pitwood relate to Gothenburg standards of 180 cubic feet; other standards to 165 cubic feet.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

and 50 million cubic feet in 1916, 1921 and 1926 respectively. A measurement of the annual home output since 1935–39 has been shown in relation to imports in Table 8 for hardwood, softwood and pitwood.

The recent production of sawn hardwood, which represents the felling of about 50 per cent. more volume of standing timber, has been until 1951 more than double the annual increment (see Table 3).

The current fellings of softwoods are less than the annual increment so that the policy of building up reserves—as emphasized in the Forestry Act of 1951—on present rates is being achieved for softwoods.

In spite of the reduction in the home production of pitwood a considerable proportion in recent years came from clear felling. This situation was in direct opposition to the aim of building up timber reserves at home, and methods of countering it are described below.

The decade before the second world war found increasing attention being paid to the possibilities of making more intensive use of home-grown timber. This is apparent from the annual reports of the Forestry Commission, which, although it had not yet become a large seller of timber, would extend its proportion in the future. For private forestry "the economic basis of silviculture was obviously the remunerative disposal of timber. Owners of private woodlands could not be expected to replant unless there is a reasonable prospect of profit" (16). It was with such ideas and the need to dispose of supplies from existing woods as well as to promote forestry in general that the Forestry Commission set up an Inter-Departmental Committee in 1931 "to investigate and submit proposals for improvement in the utilization of home-grown timber."

The Inter-Departmental Committee came to the conclusion that this extension could best be attained by studying and publicizing the timber requirements of a few select trades and the supplies of suitable timber available to meet their requirements. This was later carried into practice, and four reports represented the fruits of the appropriate studies (34–37).

In judging the contribution which home forestry is likely to make to future supplies several things should now have been made clear. Firstly, the character of the existing woodlands has been greatly changed in the past generation or so as a result of the heavy war-time fellings, and because the new plantings have shifted away to a great extent from the more traditional and indigenous species of hardwoods and softwoods to the exotic and quick-growing species of softwood; secondly, the new forest policy has emphasized the need to build up a safety reserve for emergencies and to achieve more regular and intensive production from the woodland areas.

The current policy thus implies a concentration on building up. The size and details of the task as measured by planting areas can be assessed from the Forestry Commission Report on Post-War Policy (33) and from the 1947–1949 Woodland Census. Approximately by 1995 three million acres of bare land should have been afforestated and two million acres of existing woodlands restored to productivity. The afforestation work, as distinct from replanting, is likely to be made entirely by the Forestry Commission, which had at the end of 1952 planted about 600,000 acres. Private woodland owners, who possess about one million acres of reasonably productive woodland, are faced with the task of doubling their productive woodland areas. The census data have drawn attention to the fact that as most of the existing softwoods are in young age classes, there should be an increasing production from thinnings for some time to come. The Forestry Commission estimated that there would be an increment of 12 and 28 million cubic feet of softwoods and hardwoods respectively for 1950. The broad expectation was that in the next three decades the softwood production would show a steady and rapid progression, whereas hardwood production would stabilize itself at a level only slightly below the 1950 estimate.

For the future a special problem arises from the fact that the bulk of the woodland areas suitable for hardwoods is in private hands, whereas the great bulk of the Forestry Commission areas is most suitable for conifers. In view of the generally much longer deferred return which is implied in planting hardwoods, as opposed to softwoods, the investment in the former makes less appeal to the private individual.

The current volumes and age distributions of softwoods suggest that under the present aims of policy, in thirty years' time they will provide more than 10 per cent. of the present restricted supplies of sawn softwoods. The smaller sizes of softwood thinnings will, however, present a major disposal problem in the immediate future. It is reasonable, however, to expect that the proportion of home-grown pitprops will increase. The Forestry Commissioners and the private

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

woodland interests have agreed to work together to persuade the National Coal Board to take suitable thinnings for pitprops at a reasonable price. Approved lists of prices have been drawn up for 1952 and 1953 which have been agreed to by the National Coal Board and the Federated Home Timber Associations, and in the national long term interest it is essential that clear felling to provide pitwood—as has continued in post-war years—be stopped. The fact that thinnings are more costly to handle than clear fellings has been recognized in the subsidy of 3*d*. per cubic foot for conifers or £3·75 per acre, which has been offered for all thinnings since the beginning of 1949. Under a new arrangement which started in October 1951, the grant of £3·75 per acre could be obtained for the first and second thinnings of all species with certain limits of height, or alternatively of growth.

IV. PRICES

a) *Imported*

Variations in quality is one of the limitations which has to be contended with in using some of the series of prices data on imports. For example, in the days before pitprops were separately shown in the Trade Returns they were included in the former very broad category of "hewn wood", which had come to contain a large proportion of pitprops in relation to the other and more highly priced forms of round wood. Hiley has used the two categories of hewn, and sawn and split wood, which were used in the Saurbeck-Statist Index to show the movement of prices from 1846–1927, and has calculated a table, "Corrected Relative Prices", for these by using the corresponding Saurbeck-Statist index numbers. He also made a similar calculation from 1871–1928 for sawn and split fir and teak against the Board of Trade wholesale index numbers.

To provide a check, at least in part, to this drawback of varying quality (associated with some of the relatively large categories in the Import list such as "sawn softwoods"), which also affects most series of data on home-grown timber, comparisons can be made with the prices of standardized products such as the uniform redwood batons which are sold through the Finnish, Swedish and Russian trades. One such series is, from 1909, available from one of the importing firms which have been engaged in a specialized trade over a long series of years and from other sources.* The price trends emphasize the high degree of competition which existed in the sawn softwood trade.

Reference to Table 6 suggests that the selected categories of imports from Russia, Finland and Sweden did not have the same price fluctuations as, say, the sawn softwood categories and the unit value of timber imports as a whole on the c.i.f. basis. When compared with the movement of wholesale prices in general it is apparent that the softwood prices follow this index fairly closely, and more closely than does the index for Burma teak. From 1920 to the end of the second world war the softwood indices were at a slightly lower level than the index of wholesale prices, but afterwards the softwood timber indices have been at a higher level. An indication of the price spreads which have existed in the past for Swedish and Russian redwood timber are also available from the same source (Messrs. Churchill and Sim) from 1909 and from 1921 respectively.

(b) *Home-Grown*

General discussions on home-grown timber prices have been considerably circumscribed by the lack of fundamental data of the various price movements of different categories of timber.

* In this connection, for example, Messrs. Churchill and Sim have produced useful comparative price series on a number of softwood grades. This firm also provides valuable monthly analyses based on the Trade and Navigation Accounts which indicate the percentage movement of prices and of volumes in relation to 1938 levels (52). Messrs. William Brandts prepared a statement of statistics which shows the trade in softwoods between the main exporting and importing countries in 1912, some pre-war years, and each year since 1946 (48). Messrs. C. Leary & Co. have provided data on the price movement of teak planks of uniform sizes; they also issue a market report on the main trends and problems of trade during each year (62). Comprehensive sattistics of the area, production, consumption and trade, and forestry balances, etc., of the more important categories of timber are published in the Year Book of Forest Produce Statistics published since 1947 by F.A.O. for the world as a whole (46). A similar kind of treatment is also published quarterly for Europe by the Economic Commission for Europe and F.A.O. (43). Another United Nations publication, *Unasylva*, has regular commodity reports on a large variety of important categories such as sawn softwoods, pitprops, railway sleepers, pulp wodd and so on, which gives an indicaton of current problems and prospects (47).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

This lack has recently been particularly evident in the Sixteenth Report of the Select Committee on Estimates which dealt with forestry policy and finance (40). The study of timber prices in Britain over a period of years is beset with many difficulties. There are many limitations in the use of price data derived from estate records, for it is not always clear where, say, an average price is quoted for the year, what proportion is sold standing, felled, delivered or free on rail. Moreover, the distance from markets or point of delivery and the fact that the quality may vary greatly will directly hamper the making of valid comparisons from year to year.

In view of these considerations the writer believed that the most appropriate and convenient method of assessing the broad price movements of home-grown timber in general lay in the study of the prices of certain selected and highly standardized products. With certain qualifications these could be regarded as being representative of demand changes for home-grown timber generally. The prices indices described here (Table 7) were based on this assumption, and relate to a series of prices of standard products which are of some considerable significance to private woodland owners. The choice of selected and standard commodities means that variations due to quality are reduced to a minimum, although in the urgency of war standards were relaxed. Standard products probably have to suffer more direct and effective competition from the corresponding imports. Thus it is difficult to state how far the price fluctuations of the chosen commodities can be taken as a guide for the price movements of other important categories of home-grown timber; for example, mature standing timber.* During the period of price control these prices indices reached higher levels than those measuring the controlled price of mature standing timber.

The main directions in which there were wartime relaxations in the standard of quality of the non-mining timber material were on such features as knots, depth of sapwood and deficiencies in heartwood, etc. There were also some relaxations which allowed the inclusion of species previously ruled out. This situation, however, is one that might be expected to affect most classes of timber. Thus it could be expected that even relatively poor qualities of mature timber, when there was great scarcity, would fetch the maximum control prices equally well with the high quality produce. Very special qualities of timber received an even higher price under "selected" categories. In making comparisons with the price of other home-grown categories it should be noted that the indices refer to delivered or free-on-rail timber as indicated in Table 7. It is not known how much the home-grown proportion of the chosen commodities has varied over the period covered by the data.

While it is valid to combine the first four categories of the Table in a combined index in column 5, the correctness of doing the same for the three types of pitwood is open to objections as the combined total is likely to be dominated largely by the "other conifer" types. In a recent year the proportions were approximately, in a sample for South Wales, 10 per cent. hardwoods, 15 per cent. larch and 75 per cent "other conifers". Special price agreements have been made between the National Coal Board and the Federated Home-Timber Associations for pitprops since December, 1951. (see pp. 309–10).

(c) *Net Income of British Forestry*

As few woodlands on private estates, because of irregular treatment and fellings, can be regarded as going concerns, it is somewhat difficult to determine the relationship between prices and costs. In the circumstances a better idea of the net income possibilities can be obtained although only for a very limited number of estates from the actual data of woodland accounts over a period of time (64, 65).

It is probable that incentives in forestry will only have long-term, or temporary, effects on production levels. In Britain the question of the effect of incentives on private forestry is likely

* In September 1939, home-grown standing timber over certain diameters was subject to Maximum Price Control Orders. These prices were altered once only during the period of controls—which lasted until December, 1949—at the beginning of 1947, when they were raised by about 25 per cent. (39) (see Table 9).

The series of Statutory Rules and Orders which governed various categories of the timber trade during the period of price control are a useful source of price data. Those which introduced price changes were as follows: 1939 (No. 1031); 1940 (Nos. 737, 1098, and 1565); 1941 (Nos. 114 and 2088); 1944 (No. 919); 1946 (Nos. 1566 to 2209); 1947 (Nos. 94 and 1524); and 1949 (Nos. 497 and 2362).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to be masked because the Dedication Scheme rules of good forestry, as provided in the Forestry Act of 1947, should have a direct improving effect whether an economic incentive exists or not. These rules should ensure that production will increase from thinnings made in the interest of good silviculture. The relative smallness of the standing reserves, even in the absence of official control of the scale of felling, implies that an incentive could only bring a limited and temporary response in the production of sawn timber.

In the recent past, during and since the period of World War II, it can be said that an economic incentive hardly existed. This belief is perhaps more clearly comprehended from the indicators shown in Table 9. Even when allowance was made for the fact that costs and wages were relatively low in the period which saw the formation of the timber felled during the war, it was shown that on an average the controlled prices of coniferous timber fell short of being incentive prices by as much as 42 per cent. (58).

It was claimed by the Board of Trade that the 1939 prices were fixed at a level of 50 per cent. above the prices ruling in a ten-year period before the war in order to allow for the expected war-time inflationary pressures (40). It was probable, however, that this base period, which included one of the greatest world-wide economic depressions, coincided with the period of the lowest timber prices for several generations.

TABLE 9

Relative Economic Position of British Forestry During the Period of Price Control, 1939–49

1939 = 100

Index of—	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
Sawn soft import prices c.i.f. (1) . . .	184	242	252	302	312	270	299	362	392	372
Forestry wages (2) . .	107	139	173	173	188	188	202	231	260	260
Wholesale prices (3). .	133	149	155	158	161	164	170	187	213	224
Home-grown timber: (4)										
Delivered price . .	134	138	149	152	153	154	154	199	201	200
Standing price . .	100	100	100	100	100	100	100	125	125	125

(1) Sources: Trade and Navigation Accounts; (2) Refs. 66 and 70; (3) Board of Trade; (4) Refs. 67 and 70.

A comparison of the controlled prices ruling in 1919 (75) and in the 1939–49 period—especially in the later years—helps to emphasize that the prices had not moved in line with costs. Since price control was removed at the end of 1949 substantial increases in standing timber prices have been recorded, although there was a general recession in the early months of 1952. The costs in British forestry have been measured in a study (66) of weekly wage rates in the period since

TABLE 10

Index Number of Weekly Forestry Wages, 1824–1953.*

1938 (34*s.* 1*d.*) = 100

Year	*Index*	*Year*	*Index*	*Year*	*Index*	*Year*	*Index*
1824	28	1917	70	1929	93	1941	141
1833	30	1918 (Sept.)	77	1930	93	1942	176
1837	30	1918 (Winter)	93	1931	93	1943	176
1850–51	28	1919	109	1932	91	1944	191
1860–61	33	1920 (April)	123	1933	88	1945	191
1867–71	37	1920 (Aug.)	135	1934	88	1946	205
1879–81	40	1921	123	1935	91	1947	235
1892–93	40	1924	51	1936	93	1948	264
1898	42	1925	93	1937	95	1949	264
1902	42	1926	93	1938	100	1950	276
1907	44	1927	93	1939	102	1951	293
1914	49	1928	93	1940	109	1952	317
						1953	332

* Great Britain only.

Source: Refs. 66 and 70.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

1824, and these are shown for the period under review as an index number with 1938 as 100 (Table 10). While such an index does not allow for the effect of holidays with pay, increased employers' insurance contributions and for reduction in the hours worked per week, if these changes were taken into consideration in the above table the index of 260 in 1949 would probably be about 300. Similar considerations would be necessary in interpreting the data for more recent years.

In this situation, and recognizing that forestry is a long term investment, the idea of giving some assurances about future prices was explored by the writer (68). It was suggested that forward prices could be based on a formula which took into consideration the movement of wages as the chief item of cost, and also the movement of imported timber prices.

At the end of 1951, with the help of grants from the Forestry Commission, the Departments of Forestry at Aberdeen and Oxford Universities started to make surveys of private forestry costs on samples on estates in Scotland, and England and Wales respectively (70). In addition to costs the survey is likely to give information about the economic problems of private forestry, including aspects of net income.

V. Supplies and Prices of Imported, and Supplies of Home Produced Timber Products

(a) *Plywood*

Plywood was separately distinguished in the Trade and Navigation Accounts from 1926 onwards. It was originally measured in square feet, but from 1933 in cubic feet. Apart from slight recessions in 1930, 1931 and 1933 the volume of these imports showed a distinct tendency to rise and the value exceeded £2 million from 1928 onwards. Thereafter the volume of imports rose rapidly to 1937, when the peak of recorded imports was reached at 15·8 million cubic feet for a value of nearly £5 million. Pre-war, Finland and Russia were by far the most important suppliers, although the contribution of "other countries" suggests that the supplies came from a large number of individual countries. The decline in volume which subsequently set in continued until 1941, from which year there was a distinct recovery—which almost reached pre-war level—to 1947, to be followed by a cut of one-third in 1948 and a partial recovery in 1949, and a slight reduction again in 1950. The 1951 volume of imports was the highest of the war and post-war years (including 1952), and was about the same as in 1938. The value of the import was over £12 million in 1947, and in 1951 it exceeded £17 million.

During World War II Canada and the United States became the chief sources, but since then Finland has come to re-occupy her former place as chief supplier. Although Russia has been sending some plywood in earlier years these were not indicated separately in the returns until 1950 and 1951, when she was the next most important source after Finland.

The domestic production of plywood in the United Kingdom is shown in the *Monthly Digest of Statistics* since 1942, when it was 7·33 million square feet. In 1949 the production had increased tenfold to 73·32 million square feet. There have been very slight reductions in the two succeeding years—the production for 1951 and 1952 equalling 65 and 48 million square feet respectively.

The United Kingdom production, consumption and stocks of plywood since 1940 when available are to be found in the *Monthly Digest of Statistics*, while estimates of supplies for 1949 to 1953 were made in the Keith Price Report (11). The actual consumption of plywood by main consuming industries is discussed later.

(b) *Fibre Building Boards*

The production of building boards and the consumption of other paper and boards (including building boards) since 1939 is shown in the *Monthly Digest of Statistics* (13). During the war there was a decline in the home production to about two-thirds of the 1940 output in 1945; since then there has been a fairly steady rise, which has substantially exceeded the 1940 amount since 1948. A similar trend has been shown in the consumption of "building boards with other paper and boards", although here the lowest level was reached in 1943, and a steady increase has been apparent each year since then, with the 1951 level reaching that of 1939 for the first time.

Hardboard has been imported from soft currency countries without licence since March, 1949. Since the de-control there has been a large rise in imports, but it is not very clear how far

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

this rise has been due to an accumulated demand springing directly from the restrictions caused by licensing or to the shortage of timber and plywood. The main reason for the decline in the imports of insulation board is that it had been used greatly in the post-war growth of temporary housing. The demand has been directly and rapidly affected by the cut in the housing programme at this time. The large imports in 1947 and 1948 enabled stocks to be built up and imports had been restricted as a result. The raw material for the home manufacture of these boards is mainly home-grown timber or waste wood from sawmills (see Table 11).

TABLE 11

U.K. Production of Hardboard and Insulation Board

Year	Hardboard		Insulation Board	
	Million Sq. ft.	*Thousand Tons*	*Million Sq. ft.*	*Thousand Tons*
1947 . . .	24·8	8·6	53·8	17·8
1948 . . .	30·9	9·7	64·3	20·8
1949 . . .	35·6	10·6	71·0	23·0
1950 . . .	34·9	10·2	63·9	20·3
1951 . . .	43·6	12·6	74·2	23·4
1952 . . .	27·8	8·4	67·0	21·3

(c) *Pulp and Paper*

The main uses of wood pulp are for paper board, insulation boards, cellulose, and for a variety of chemical industries, including rayon. As it is thus a relatively complex industry to follow it is not intended to examine the statistics in any detailed way here, although it is necessary to stress that there is often a high degree of competition for the growing raw material, either as pitprops or as pulpwood, and this may pose some very large economic problems. These are apparent in post-war years from the study, for example, of the European statistics in the *Quarterly Bulletin of Timber Statistics* (43).

The scale and cost of the United Kingdom requirements of pulp is readily appreciated from the import statistics which distinguish "mechanical" and "chemical" pulp back to 1901. In 1938 the United Kingdom was the world's largest importer, and in recent years has been second after the U.S.A.

Up till the pre-war years the import and export data of the various forms of paper and pulp have been shown in a fairly uniform way. For the pulp or the appropriate raw material the reliance is very heavily on imports. The availability of future supplies of pulp and paper in the United Kingdom is thus dependent largely on the volume of international trade in these commodities—which have been thoroughly studied by F.A.O. (44–46), and on the purchasing power which may be made available for specific commodities. There are many evidences of restricted uses in these and products of prepared pulp in the United Kingdom during and since the war. The general trend of supplies is upwards over the period, except for the interruptions of war. The categories are too numerous to describe in detail here. Data on production, consumption and stocks for the more recent years are shown in the *Monthly Digest of Statistics.*

The import data do not differentiate between newsprint and other forms of paper before 1920, but it is clear that, as with wood-pulp, there was a steady increase in the quantities over the period which was severely affected by the two world wars. In many years the newsprint proportion appeared to be about a third of the total paper category of imports, and over the period since it was differentiated from other paper the proportion was just over one-half.

More detailed information about paper requirements since 1939 is shown in the *Monthly Digest of Statistics,* which indicates for certain years the main materials used, the type and value of production, the amount of exports and the amount available for use in the United Kingdom. A fairly comprehensive study of the special problems of the trade and industry connected with newsprint and other forms of paper has been prepared on behalf of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) by the Intelligence Unit of the *Economist.* This appeared under the title of *The Problem of Newsprint and Other Printing Paper* as publication No. 594 of UNESCO in 1949.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

VI. Stocks of Timber and of Timber Products

Regular information on United Kingdom stocks of timber and of timber products does not appear to have been available before 1940. Since 1940 it is possible to set out (from the *Monthly Digest of Statistics*) (13) the stocks, usually in relation to production and consumption for the country as a whole for softwood, hardwood, pitwood, plywood, and some pulp and paper products. Some information, however, was published on stocks of sawn and planed softwoods by the Timber Trades Federation before the 1939 war (15). The Federation estimated the stocks in first hand, and related them to changes in stocks, total imports and deliveries as follows:

Table 12

Total United Kingdom Stocks of Sawn and Planed Softwoods in First Hands, Related to Changes in Stocks, Total Imports and Deliveries

'000 *Standards*

Date	*Stocks in First Hands*	*Changes in Stocks*	*Total Imports*	*Delivered from First Hands*
1st October 1938	795			
1st November 1938		+35	625	540
1st December 1938				
1st January 1939	880	−20	128	148
1st February 1939	860	−55	74	129·5
1st March 1939	805	−95	57	152
1st April 1939	710	−80	48	128
1st May 1939	630	−90	112	202
1st June 1939	540	+15	227	212
1st July 1939	555	+ 5	263	258
1st August 1939	560		—	—

These data corroborate the fact that in a normal pre-war year stocks sank to their lowest levels in June. July was usually the most active month for imports, and the stocks gradually accumulated until about January. The regularity of this cyclical tendency is clear from the statistics of monthly imports of sawn and planed softwoods, and is associated with the seasonal shipment when many of the ports of shipment are free from ice (52, 71). Along with the statistics of total imports of sawn and planed softwoods, there appeared corresponding data of London Docks stocks, deliveries and imports.

The nation's softwood stocks at the end of 1951 were, for the first time, in excess of the level ruling in 1940. Apart from 1943, when they were nearly a quarter of the total, the home produced stocks have remained only as an insignificant proportion of the total. By 1948 the stocks of pitwood had nearly recovered to their 1940 level, while hardwood and plywood stocks were exceptional in that they were distinctly higher in most years than the 1940 levels.

Of the items classified as paper-making materials, newsprint, and "other paper and board", in recent years, pulpwood, wood pulp and boards have shown stocks at levels which tended to be higher than in 1940, while the other products showed lower levels until 1951, when a substantial increase is generally apparent. Stocks for most individual products have shown wide fluctuations in successive years. For most of these categories stocks are shown for 1939.

The Annual Statement of Trade (Volume IV) gives the details of imports entering each port, and if it were possible to get some idea of the trend of stocks held at some of the main ports, estimates of stocks for the country as a whole in pre-war years might be made. Examination of stocks data such as that of the Port of London Authority, which has a series of timber stocks each March 31st from 1914, revealed the difficulty of making out estimates for the country as a whole.

VII. Consumption

Relatively sparse information exists upon the manner in which the timber supplies in the United Kingdom are consumed. The data on licensing during and since the second world war

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

have proved to be an unreliable guide to actual consumption in individual trades. A Committee, under the Chairmanship of Sir Keith Price, set out in 1948 to estimate the probable requirements and supplies of timber for the United Kingdom for the period 1949–1953 (11). Mention has already been made of the special inquiries made in the 1930's by the Forestry Commission into the timber demands of selected industries (34–37).

Much statistical information about the number of establishments, gross output, cost of materials used, net output, number employed and net output per person are given in the Final Report of the Census of Production carried out in certain years for the timber (sawmills, etc.) trade, furniture and upholstery, coopering, cane and wicker furniture and basket work, and wooden gates, cases, boxes, and trunks (7). The latest census, for 1948, showed that the gross output for 1885 establishments, each employing more than ten persons, was £109,586,000, or more than three times as much as that of the 1,524 similar establishments in 1935 when the production was valued at £32,479,000.

On the assumption that sawn timber imports—owing to wastage in their production—represented about 50 per cent. of their standing volume, Hiley made some estimates of the standing timber equivalent of Britain's consumption, in quinquennial periods from 1846 to 1926. The consumption per head rose steadily until 1901, when it was three times the amount of 1846 (59). In this period Britain was very active industrially and the population rose rapidly. The subsequent data show that the consumption per head registered in 1901 was not surpassed until 1936. Before World War I it was known that there was a shortage of houses, and this was regarded as part of the explanation of the high consumption in 1901. Even the revival in house building after the war did not restore per head consumption to the level ruling at the beginning of the century, and the substitution of other materials for wood in construction, office furniture and so on was suggested as the most probable influence.

The second world war has brought unexpected influences in the demands for timber. Some, such as the reparation of damaged buildings, the need to catch up with house building held in check during the war, the expansion in our post-war exports, have all—apart altogether from the vast consumption during wartime itself—created unusual and extra demands on timber supplies. The war disrupted the normal sources, and shifted much of the demand to the limited reserves of home-grown timber. The depletion of these reserves makes it likely that a larger proportion than in recent years of our requirement—for sawn timber at any rate—will have to be imported. More recently the difficulties over foreign exchange, particularly of dollars, and the political cleavage of the world since the war have shifted the pattern of the sources of imports. In the early months of 1952 it appeared that it was still a "seller's market" for timber. Thus, while it might be expected that, in view of the influences just listed, there would be a big increase in the demand, this has remained potential rather than effective demand because of restrictions in supply due to price, dollar shortage and political restrictions.*

According to the Keith Price Report, before 1939 timber was, both in terms of volume and value, the most important raw material imported by the United Kingdom. In the absence of any reliable statistics either in total or by main consuming industries, the United Kingdom's total consumption of softwoods, hardwoods and plywood was estimated by the Committee by adding the average annual retained imports during the years 1934 to 1938 to the small supplies of home-grown timber produced annually during the same period. The average retained imports of plywood was placed at 673, and the home production at 7 million square feet. Assuming an average thickness of 6 mm. the volume of the pre-war consumption was placed at 12·6 million cubic feet, and the corresponding consumption of softwoods and hardwoods respectively at 398 and 56 million cubic feet.

After briefly describing the special conditions which operated in the period from 1939 to 1947, such as the lack of shipping space, the reduction of imports and the great reliance on home production and the very rigid economy in use, the report went on to describe the basis for the Committee's estimate of timber requirements in 1949 to 1953. Mining timber was not included within the Committee's terms of reference. This Report was published in April, 1948, and as it included

* For Europe as a whole a study has been prepared jointly by the Secretariats of F.A.O. and E.C.E. to show the trends of consumption, production and international trade during the twentieth century and reviews the prospects in the next decade (44).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

an important statement of the United Kingdom Government of its attitude towards the general conclusions in the Report, it has been of very special value in the consideration of future trends and in judging estimates. The general impression to be gained from this Government Statement, and from more recent discussion and from events, is that the Committee took a too optimistic view both of the United Kingdom's ability to obtain supplies on the scale set out in the Report, and of its minimum needs, at any rate of sawn softwoods. It is clear that any forecast of the probable demand for timber would be best if related to actual consumption in more recent years. It is, however, realized that the present distribution of end-uses will not coincide with the pattern under free and unrestricted choice. The effect of rearmament on timber-using industries is difficult to estimate at this stage.

(a) *Softwoods*

Softwoods are by far the most important category of total United Kingdom requirements. Housing is the outstanding consumer of softwoods. In recent years there has been discussion about the possibility of raising the existing house building rate by 50 per cent. to 300,000 a year in Britain. The feasibility of doing this with existing resources has been questioned, but Bronowski has claimed that by greater specialization of sub-contractors such a goal might be achieved (49, 50). The decision to limit houses to 1·6 standards (2 in Scotland) might be regarded as an arbitrary limit, which might be altered either way at short notice. Already the limit has greatly influenced the size and form of the average house.

In thinking of the future requirements of timber for housing and other uses where there appears to be scope for considerable substitution by other materials, it will be necessary to allow to some extent for the tendency of such developments to become permanent (44). This situation might quite well arise, even when timber supplies again become more readily available and cheaper. The present shortage and high cost of timber have acted as a great stimulus to research on the possibilities with concrete and other substitutes. Many appropriate lines of substitution have been studied by the Department of Scientific and Industrial Research at its Building Research Station (72). Apart from the actual substitution of concrete for timber in the buildings themselves, the technique of building has altered in ways which make less demands on timber. For example, wood for shuttering is used to a smaller extent. Moreover, the use of pre-cast products removes the need for shuttering. Scaffolding is now almost entirely constructed of steel poles.

It is difficult to gauge exactly the degree of substitution which has taken place of the lighter hardwoods bought with soft currencies for softwoods bought with hard currencies. That the substitution takes place, however, may be inferred from the high current rate of hardwood consumption, which is more than half as much again as pre-war, in the high prices for lighter hardwoods and the high imports of poplar from France. It is highly probable that if softwoods were freely available at a cheap price, hardwood consumption would greatly decline.

Timber economy memoranda were issued during and since the war by the Ministry of Works, and these indicate in great detail the specifications and type of timber which were allowed for specific purposes. Frequently, traditional uses of softwood were omitted, usually hardwood, concrete or metal were recommended as alternatives.

The post-war export drive of the United Kingdom is not without considerable influence on the demand for softwoods as packing material.

(b) *Pitwood*

The most important market which is likely to arise for the thinnings from expanding areas of forest is for pitprops. The quantity of pitwood required annually in the United Kingdom can be inferred as about 80 million hoppus cubic feet. During the war years, during the Battle of the Atlantic, it was decided to rely almost entirely on home-produced pitprops, but since then the tendency has been for the home proportion to decline. In view of the potential supply of suitable raw material for pitprops in the silviculturally-made thinnings of British Forestry, and the fact that the price of the imported pitprop had risen by more than five times between 1938 and the end of 1951 (6½ times by September, 1952), there is ground for believing that the total supply of imports may be reduced in favour of a gradually increasing volume of home production.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(c) *Hardwoods*

In 1948 the Keith Price Committee in its report drew attention to the large number of countries supplying hardwoods, and the large number of hardwood species (over 300) used in the United Kingdom. European and tropical supplies were also greatly reduced during the war and afterwards a high proportion of the reduced supply came from Canada and U.S.A. Germany sent most of the European contribution, and about 70 per cent. of the tropical supplies came from the Commonwealth, and West Africa in particular. Since 1946, apart from 1948, the British Colonies have sent about a fifth to a quarter of total United Kingdom imports, and especially since 1949 showed a tendency to increase that proportion at the expense of North America and the other sources (14).

At the end of the war, the furniture trade, together with transport and engineering, probably took about two-thirds of the supplies of hardwood, and the furniture trade was much the most important user. According to the report of the Working Party on the furniture industry (10) the requirement for the furniture industry for 1950 was estimated at 35 million cubic feet of softwood and hardwood and 420 million square feet of plywood. This compares with the actual consumption in 1937 of 28 million cubic feet and 340 million square feet respectively.

The chief home-grown species used in the furniture trade are oak, beech, ash and birch. Most of the oak used in the trade is imported, but the previous main source of supply from U.S.A. is now severely restricted. New species from West Africa are now being used in increasing quantities and these, to some extent, take the place of the supplies from U.S.A. Although the estimated consumption is getting up to the pre-war amounts, there does not appear to be any strong indication that home grown timber will constitute a very high proportion or gain much from the general expansion.

The construction and repair of railway wagons has absorbed a significant proportion of home-grown timber in long lengths, particularly of oak. Since the end of the war nearly two million cubic feet of timber has been so used annually. The shortage of suitable timber and the building of steel wagons will reduce the amount of timber used in this industry. Pitwood represents another important outlet for hardwoods.

In view of the war-time depletions and the need to build up a reserve, it is clear that although home-grown hardwoods in recent years have provided over 50 per cent. of our supplies, the proportion and volume is almost certain to decline. Individual species of quick-growing hardwood trees, like poplar, will be encouraged to fill special needs.

(d) *Plywood and Veneers.*

Before the war little plywood had been produced in the United Kingdom and the existing capacity was developed during the war. Its continuance as an industry depended to a great extent on the ability to import suitable logs for peeling, and also veneer. Furthermore, as production costs in the United Kingdom tended to be rather high in relation to imported plywood, the scale of home production would be sensitive to any increase in the availability of imports. Such an increase depended essentially on the rate of expansion in countries with a potentially high export like Finland, Russia, U.S.A. and Canada. The actual scale of imports in the event of greater availability would depend mainly on the price and currency situation. The Keith Price Committee, as it had done for softwoods and hardwoods, made estimates of the amounts likely to be forthcoming from probable and possible supplying countries.

In its reference to veneers—as distinct from plywood proper—the Keith Price Committee pointed out that some of the United Kingdom plywood factories were not equipped to peel logs, and thus depended on imported supplies of veneers and, to a lesser extent, on imported logs which were peeled in the United Kingdom by veneer plants. Furthermore, a wide range of veneers was required for decorative purposes in furniture, ship building and manufactured exports. Adequate supplies were expected to exist in the main exporters—Canada, U.S.A. and West Africa —and also from Europe, and in particular France. Logs for veneers were included in the Committee's estimate of hardwoods, but as the veneer position was likely to be satisfactory no detailed estimates of veneer imports had been made. On the whole, as imported supplies were received from traditional sources, no great difficulty was expected in the maintenance of a reasonable level of plywood.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(e) *Fibre Building Boards*

A close correlation exists between the total requirements of fibre boards and the level of the house and building programme. It seems probable, however, that although the housing programme has fluctuated since the end of the war, rearmament has introduced a fresh demand for these boards. In the past the United Kingdom has given little attention to insulation of houses because it has made rather a lavish use of its coal. Now that fuel supplies generally are scarce it is possible that the need for insulation will be felt more and more, and this is regarded as being one of the more important influences likely to increase greatly the demand for fibre boarding and plywood.

(f) *Paper and Pulp*

The consumption of paper-making materials in recent years is readily obtainable from the *Monthly Digest of Statistics*. It is clear that the bulk of the wood pulp is used for paper making. A large proportion of paper is, however, made from materials other than wood pulp. These are shown as a total in terms of paper equivalent, the most important being waste paper, straw, rags, ropes, etc., and pulp wood which includes wood-waste and chippings.

The chief production from these raw materials is other paper (as distinct from newsprint) and board, newsprint, and building boards. The production of other paper and board and building board, after falling to little more than half in 1943, had by 1949 got fairly close to the 1939 quantities, and in the more recent years to the end of 1951 the upward trend has been continued. The production of newsprint had followed much the same course but in 1949 was little more than half of the 1939 production, although in 1950 and 1951 the proportion had gone up to about two-thirds of that level.

The consumption of other paper and board, including building boards, exceeded the 1939 level in 1951 for the first time since the war started. Newsprint, on the other hand, was still little over one-half of the 1939 amounts by 1951. The statistics for paper and pulp commodities suggest that it would be reasonable to expect a continuation of the decidedly upward trends. This view is confirmed and qualified in the Statement by the United Kingdom, at the preparatory Conference on World Pulp Problems in May, 1949 (45), which made an estimate—although admitting that forward estimates must be largely conjectural—that by 1952 the United Kingdom would require pulp in the pre-war quantity. These quantities did, however, represent more than the country could afford at the then current prices. They were also dependent on the United Kingdom balance of payments position with the various individual supplying countries.

VII. Miscellaneous and General Sources of Timber Statistics

There are many aspects of forestry and of timber production in the United Kingdom about which statistics are produced from time to time. In addition to the more important sources of data relating to the main sections described above, there is much periodic literature which can be selected for specific information. The very comprehensive library at the Department of Forestry, Oxford University, houses three important and separate classifications of this literature; (1) the "Troup Classification", which covers the period up to December 31st, 1933, of the periodical literature, etc., then existing in the library (76); (2) the "Flury Classification", which consists of a card catalogue and covers the period 1934–1950 (77); and (3) the "Oxford Classification", which has been operating since March, 1951. The second and third of these are based on a decimal system of classification, and since 1939 most of the individual items appearing in the card catalogue have also appeared in *Forestry Abstracts*, which have been published quarterly since 1939 in the same classification as the card catalogue by the Commonwealth Forestry Bureau. The Bureau is housed in the Imperial Forestry Institute at the Department of Forestry in Oxford.

Forestry Abstracts, which has a world wide circulation, and covers world-wide sources from over 30 languages, constitutes an excellent basis for the investigation of any specific aspect of forestry. Among sections likely to include at least incidental references to statistics are those dealing with increment; development and structure of timber stands; business economics of forestry; marketing; economics of transport and the wood industries; foresters and forestry from the national point of view; and social economics of forestry.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

BIBLIOGRAPHY

Publication from Government Departments and International Organizations

Board of Agriculture and Fisheries

(1) *Agricultural Statistics, Great Britain*, 1905; Cd. 3061. H.M.S.O.
(2) *Agricultural Statistics, England and Wales*, 1913; Cd. 7325. H.M.S.O.
(3) *Agricultural Statistics, Scotland*, 1914; Cd. 7958. H.M.S.O.
(4) *The Agricultural Output of Great Britain*, 1912. H.M.S.O.
(5) *Offices of Woods, Forests and Land Revenues; Joint Annual Report of the Forestry Branches for the year* 1912–1913; Cd. 7488, 1914. H.M.S.O.
(6) *Report on Supplies of Home-Grown Pitwood in England and Wales.* H.M.S.O., 1914.

Board of Trade

(7) *Final Reports on Censuses of Production* (for certain years—1907, 1924, 1930, 1935 and 1948).
(8) *Import Duties Act Inquiries* (since 1933).
(9) *Annual Statement of Trade.*
(10) *Furniture; Working Party Report.* H.M.S.O., 1946.
(11) *Report of the Committee Appointed to Consider the United Kingdom's Probable Requirements and Supplies of Timber and Plywood, 1949 to 1953; with a Statement by His Majesty's Government.* H.M.S.O., 1948.
(12) *Reports to the Board of Trade upon the Supply of Imported Pit Timber with Special Reference to the Resources of Newfoundland and the Maritime Provinces of Eastern Canada;* Cd. 7728. H.M.S.O. 1914.

Central Statistical Office

(13) *Monthly Digest of Statistics.* H.M.S.O.

Colonial Office

(14) *Colonial Primary Products*, No. 238. H.M.S.O., 1949.

Committee Internationale du Bois

(15) *Timber Statistical Review Incorporating the Committee Internationale du Bois Monthly* (English Edition) Nos. 1 and 2: July and August, 1939.

Forestry Commission

(16) *Annual Reports of the Forestry Commissioners.*
(17) *Report on Forest Research for the Year Ending March*, 1949. H.M.S.O., 1950.
(18) *Report on Census of Woodlands and Census of Production of Home-Grown Timber*, 1924. H.M.S.O., 1928.
(19) *Report on Census of Production of Home-Grown Timber*, 1930. H.M.S.O., 1932.
(20) *Census of Woodlands* 1947–1949, *Summary Report, Forest Record No.* 3, 1951.
(21) *Census of Woodlands*, 1947–1949; *Woodlands of Five Acres and Over.* Census Report No. 1. H.M.S.O., 1952.
(22) *Hedgerow and Park Timber and Woods Under Five Acres*, 1951. Census Report No. 2. H.M.S.O., 1953.
(23) *Growth and Yield of Conifers in Great Britain;* Bulletin No. 10. H.M.S.O., 1928.
(24) HUMMEL, F. C., and WATERS, W. T. (1950), *General Volume Tables for Oak in Great Britain: Forestry Record No.* 5. H.M.S.O.
(25) HUMMEL, F. C., and WATERS, W. T. (1950), *General Volume Tables for Beech in Great Britain: Forestry Record No.* 6. H.M.S.O.
(26) HUMMEL, F. C., and WATERS, W. T. (1950), *General Volume Tables for Birch in Great Britain: Forestry Record No..* 7. H.M.S.O.
(27) HUMMEL, F. C., ERVINE, T. W., and JEFFERIES, J. (1950), *General Volume Tables for Scots Pine in Great Britain : Forestry Record No.* 8 H.M.S.O.
(28) HUMMEL, F. C., ERVINE, T. W., and JEFFERIES, J. (1950), *General Volume Tables for European Larch in Great Britain: Forestry Record No..* 9. H.M.S.O.
(29) HUMMEL, F. C., ERVINE, T. W., and JEFFERIES, J. (1950), *General Volume Tables for Norway Spuce in Great Britain: Forestry Record No.* 10. H.M.S.O.
(30) HUMMEL, F. C., ERVINE, T. W., and JEFFERIES, J. (1951), *General Volume Tables for Corsican Pine in Great Britain: Forestry Record No.* 11. H.M.S.O.
(31) HUMMEL, F. C., ERVINE, T. W., and JEFFERIES, J. (1951), *General Volume Tables for Japanese Larch in Great Britain: Forestry Record No.* 14. H.M.S.O.
(32) HUMMEL, F. C., ERVINE, T. W., and JEFFERIES, J. (1951), *General Volume Tables for Douglas Fir in Great Britain: Forestry Record No.* 15. H.M.S.O.
(33) *Post-War Policy Report of Forestry Commissioners;* Cmd. 6447. H.M.S.O., 1943.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(34) Utilisation Series, No. 1; *Report on the Demand for Timber for Box and Packing-case Manufacture in Great Britain.* H.M.S.O., 1934.
(35) Utilisation Series, No. 3; *Report on the Demand for Timber in Coal Mining.* H.M.S.O., 1935.
(36) Utilisation Series, No. 4; *Report on the Demand for Timber in Wood Turning in Great Britain.* H.M.S.O., 1936.
(37) Utilisation Series, No. 4; *Report on the Demand for Timber in Ship-building and Docks and Harbours.* H.M.S.O., 1938.

Miscellaneous.

(38) *Reconstruction Committee; Final Report of Forestry Sub-Committee;* Cd. 8881. H.M.S.O., 1918.
(39) *Statutory Rules and Orders:* 1946, No. 2209; *The Control of Growing Trees and Home-Grown Round Timber in the Log (No. 3) Order,* 1946; *dated December 23rd,* 1946. H.M.S.O., 1946.
(40) *Select Committee on Estimates; The Forestry Commission, Sixteenth Report, Session* 1948–1949. H.M.S.O., 1950.
(41) *Timber Control; Seventh Report, Session* 1950. H.M.S.O., 1950.
(42) *Trading Accounts and Balance Sheets* (annually for certain Government Departments including the Forestry Commission). H.M.S.O.

United Nations

(43) "Economic Commission for Europe and Food and Agricultural Organisation, Timber Statistics (including Market Reports)", *Quarterly Bulletin.* Geneva.
(44) *European Timber Trends and Prospects; A Study Prepared Jointly by the Secretariats of Food and Agricultural Organisation of the United Nations and Economic Commission for Europe.* Geneva, 1953.
(45) Food and Agricultural Organisation; *Report of the Preparatory Conference on World Pulp Problems; Montreal, April–May,* 1949.
(46) Food and Agricultural Organisation: *Yearbook of Forest Products Statistics, Washington D.C. and Rome.* Annually since 1946.
(47) Food and Agricultural Organisation: *Unasylva.* Published six times per year since 1947.

Other Publications

(48) BRANDTS, W., & CO., *Approximate Statistics; Exports and Imports of Sawn and Planed Softwoods.* Annually.
(49) BRONOWSKI, J. (1950), "300,000 new houses a year", *The Observer,* November 5th.
(50) BRONOWSKI, J. (1949), *Output Problems in House Building.* British Association for Advancement of Science.
(51) Commonwealth Forestry Bureau: *Forestry Abstracts.* Published quarterly since 1949. Department of Forestry, University of Oxford.
(52) CHURCHILL and SIM, *Monthly Report on Principal Timber Imports to the U.K.* Extracted and computed from Board of Trade Accounts.
(53) "Comparative prices of timber imported from Russia, Finland and Sweden, 1920–1949", *Timber Development Association, Quarterly Review;* October, 1948, with supplementary figures for 1948 and 1949.
(54) FINNEY, D. J. (1947), "Volume estimation of standing timber by sampling", *Forestry,* **21** (2), 179–203.
(55) FINNEY, D. J. (1948), "Random and systematic sampling in timber surveys", *Forestry,* **22** (1), 64–99.
(56) FINNEY, D. J. (1949), "An example of periodic variation in forest sampling", *Forestry,* **23** (2), 96–111.
(57) FINNEY, D. J., and PALCA, H. (1949), "The elimination of bias due to edge-effects in forest sampling", *Forestry,* **23** (1), 31–47.
(58) HILEY, W. E. (1949), "A basis for fixing controlled prices of round coniferous timber", *Forestry,* **22** (1), 4–44.
(59) HILEY, W. E. (1932), *The Economics of Forestry.* Oxford University Press.
(60) HILEY, W. E. (1949, 1950, 1952), *An Examination of the Accounts for the Years* 1946–48, (*and for the years* 1948–49, 1949–50 *and* 1950–51). Dartington Woodlands Limited.
(61) HILEY, W. E. (1931), "The Improvement of Woodlands", *Country Life.* London.
(62) LEARY & COMPANY; *Market Report; Softwoods, Hardwoods, Plywoods, Wall Boards and Timber Products.* Yearly review.
(63) MACDONALD, J. (1948), "Taper and volume tables for ash", *The Quarterly Journal of Forestry,* pp. 85–89.
(64) MACGREGOR, J. J. (1937), "The economic history of two private estates in Cambridgeshire", *Journal of Royal Agricultural Society of England.*
(65) MACGREGOR, J. J. (1949), *The Forest Economy of Three Private Estates in Great Britain.* Institute Paper, No. 25. Department of Forestry, University of Oxford.
(66) MACGREGOR, J. J. (1946), "Labour costs in English forestry since 1824", *Forestry,* **20**,30–43.
(67) MACGREGOR, J. J. (1950), "The price trends of some categories of home-grown timber, 1914–49", *Journal of the Land Agents' Society,* May, pp. 173–5.
(68) MACGREGOR, J. J. (1949), "Problems and methods of assuring prices for home-grown timber", *Quarterly Journal of Forestry,* July, pp. 119–125.
(69) MACGREGOR, J. J. (1950), "The trend of prices and volume of imported timber", *Journal of the Land Agents' Society,* June, pp. 241–6.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(70) MACGREGOR, J. J., and MUTCH, W. E. S., *Introduction to the Survey of Private Forestry Costs and First Annual Report*, 1951–52, *with Supplementary Report for* 1946–47 *to* 1951–52. Department of Forestry, University of Oxford.
(71) MALLINSON, R. F. A., and GRUGEON, R. (1950), *Timber Trade Practice*. London: Cleaver-Hume Press Ltd.
(72) MASTERMAN, O. J. (1950), "Prestressed concrete development at the field test unit, Thatched Barn", *The Structural Engineer*, **28**, No. 10, October.
(73) MAW, P. T. (1909), *The Practice of Forestry, Covering all the Financial Aspects of Afforestation*. T. Fisher Unwin.
(74) MAW, P. T. (1912), *Complete Yield Tables for British Woodlands and the Finance of British Forestry*. London: Crosby, Lockwood & Son.
(75) MEIGGS, RUSSEL (1949), *Home Timber Production*, 1939–45. Crosby Lockwood.
(76) *Reference System of Periodical Literature in Use at the Forest Library, Department of Forestry, University of Oxford*, 1930.
(77) Forest Bibliography; *An International Decimal Classification on the Basis of Melvil Dewey's System*; International Union of Forest Research Organisations. Oxford: Hall the Printer, 1936.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—*Quenouille* (*M. H.*). Associated Measurements	323
2.—*Trumpler* (*Robert J.*) & *Weaver* (*Harold F.*). Statistical Astronomy	324
3.—*David* (*F. N.*). A Statistical Primer.	325
4.—*Finney* (*D. J.*). Introduction to Statistical Science in Agriculture	325
5.—*Pearce* (*S. C.*). Field Experiment with Fruit Trees and other Perennial Plants	326
6.—*Waugh* (*Albert E.*). Statistical Tables and Problems	327
7.—*Lewis* (*Edward E.*). Methods of Statistical Analysis in Economics and Business	329
8.—*Mounsey* (*J.*). An Introduction to Statistical Calculations	331
9.—National Bureau of Standards. Table of Arctan X	332
10.—*Coe* (*N. E.*) *Ogborn* (*M. E.*). The Practice of Life Assurance	332

1.—*Associated Measurements.* By M. H. Quenouille. London: Butterworth's Scientific Publications, 1952. x + 242 pp. 10″. 35*s.*

Associated measurements is a title that can cover a very wide field, and the author ranges far indeed—from dot diagrams to multivariate analysis—and rapidly. He states that the amount of mathematics has been kept to the minimum necessary to explain the approaches used, and that the non-mathematician should therefore be able to follow the methods given. It is difficult in any text-book to choose and maintain an appropriate level of discussion and, with a field as wide as this, the task is almost impossible if the volume is to be kept to reasonable size; in this case the success is not complete.

The first part of the book is concerned with graphical methods of estimation and assessment of associations, after an introduction to the subject generally. The discussion covers four simple tests of the existence of association—the medial test, Tukey's corner test, an ordering test and the point-pair test—with their extensions to partial and multiple correlation. The description of the tests is not always as clear as might be desired, but it is extremely useful to find them readily available under one cover, together with appropriate tables.

The second part deals with numerical analysis, following a well-trodden path. It is pleasant to find the main assumptions on which regression analysis is based set out simply at the beginning of the chapter. Testing is discussed principally in terms of analyses of variance, rather than by means of correlation coefficients or standard errors of regression coefficients. This leads to a smooth presentation of the subject, with the various correlation coefficients falling neatly into place. On the other hand, the discussion of comparisons between regressions is heavy going and the argument is difficult to follow. An unfortunate misprint occurs when the normal equations are written down for the first time in the chapter on multiple association.

Although called "rapid estimation and analysis", the third part is really a selection of miscellaneous chapters. They deal with grouping of observations, uses of the analysis of covariance and large-scale investigations. The last section is unfortunately too brief to be very informative.

The "analytical complications" of the final part will be new territory to many readers, but although the author makes many sorties into it he never stops to consolidate his position. In sixty pages he discusses, amongst other things, the Probit transformation, underlying relationships, time series analysis, discrimination, matrix algebra, factor analysis and other problems of multivariate analysis. His approach makes the techniques appear much less laborious than they are. Having once explained serial correlation coefficients he produces the values of those he requires, giving no indication of the amount of computation involved. In dismissing principal components in three pages none of the computation is given, and he leaves an impression that the solutions are reasonably simple. To other subjects, such as factor analysis (to which he devotes four pages), he gives a sketchy introduction.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The reproduction of the book is generally good, but not entirely beyond criticism. The use of a dash instead of the word "to" for indicating a range of variables leads to considerable confusion; thus the relationship between y and x_1–x_6 turns out to be between y and six variables $x_1, x_2 \ldots x_6$. The crop of misprints is no larger than usual and most of them are obvious. However, it is unfortunate that the scatter diagrams reproduce so badly: the symbols representing points are small and get overwhelmed by the grid of the diagrams so that interpretation "at a glance" is impossible.

The bibliography is long and should be useful. In fine, the book serves a good purpose as a connected account of the processes available for the estimation and testing of associations between quantitative measurements.

F. D. K. LIDDELL.

2.—*Statistical Astronomy*. By Robert J. Trumpler and Harold F. Weaver. Berkeley: University of California (London: Cambridge University Press), 1953. 11 p l., 644 pp. $9\frac{3}{4}''$. $7.50.

Astronomers are handicapped by the nature of their subject; they must always consider what can be observed and measured, rather than what experiment could be devised to test a given theory. Within the limits imposed by observational difficulties material is abundant, and it is therefore natural that statistical methods should be employed to extract the greatest possible amount of information. In the past, many of the statistical problems of astronomy have been considered *ab initio* by the mathematical astronomers, especially Charlier, Eddington and Whittaker; but the rapid growth of general statistical methods now warrants a guide-book to the various techniques which astronomers may need to use. Such a book is *Statistical Astronomy*, by R. J. Trumpler and H. F. Weaver. It is entirely concerned with the analysis of astronomical data. The statistical foundations of stellar dynamics, of the stochastic forces due to random encounters between two stars, and of the fluctuations in the brightness of the Milky Way, are all matters which arise in theoretical astronomy, but they find no place here.

The book is essentially in three parts. There is a general introduction to statistical methods, and to the theory of integral equations. Both subjects are treated in rather much detail (220 pages in all), and the reader may feel that a briefer account would have been sufficient, especially as there are many standard books, and references to these have been given.

The sections which are of greatest value are undoubtedly those on the space distribution of the stars and on associated problems. The first problem is to find the distribution of absolute brightness among stars in the region of the Sun. The complication here is that the range of absolute brightness is so great, involving a ratio of fully a million to one, and if we confine ourselves to a small region of space then the number of intrinsically bright stars is far too small for statistical purposes. On the other hand, a large region would almost certainly contain many faint stars whose distances have not been measured, and which therefore will not be included in the star count.

A similar major problem is the determination of the density variations in the region of the Sun. This is done by means of the observed distribution of apparent brightnesses in different directions in space. Again there is the difficulty that the observational material is not complete, since the faint stars are not adequately represented except in the immediate vicinity of the Sun. A further complication is introduced by the absorption of light in interstellar space.

These chapters on the spatial distribution of stars give a clear account of the methods of analysis available, and of the uncertainties involved. The subject is one in which the authors have had much first-hand experience, and they write with good authority.

The rest of the book deals with another large field of application, the statistical study of stellar movements. Here the authors are not so convincing for they tend to analyse the observations in terms of theories which have largely been discarded. For instance, the ellipsoidal distribution of velocities (in which the components of velocity in three perpendicular directions are assumed to be distributed according to a Gaussian law, but with different dispersions) plays an important part in the historical development, but, as the authors point out, it does not fit the observations very well. In the absence of a better theory, it would have been useful to know how to combine the observations on stellar movements so as to deduce the form of velocity distribution.

Similarly the theory of galactic rotation is presented almost in its original form, and no reference is given to the modifications which have been made in recent years.

The book certainly discusses some of the most fascinating problems in astronomy, and gives many references to original papers—though references to the more recent ones are a little unrepresentative. It should stimulate interest in star-counting problems at a time when improvements in observational technique have made such investigations more economical of time and labour.

G. L. CAMM.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

3.—*A Statistical Primer.* By F. N. David. London: Griffin, 1953. x+226 pp. 8″. 22*s*.

In spite of the profusion of elementary books on statistics, of varying shades of sophistication, Dr. David has managed to find a niche hitherto unoccupied. This book is based on lectures given by the author to scientists, who, she finds, are "able to digest simple statistical ideas and such mathematical symbols as are necessary to formulate them." She avoids algebraic arguments as far as possible, and illustrates the techniques with a large number of realistic examples and useful diagrams. Most of the examples are biological, and many are based on data presented in the early volumes of *Biometrika*.

The special feature of Dr. David's primer is the extreme patience with which the most difficult concepts of elementary statistical method are presented. Scientists meeting for the first time the concepts of sampling distributions or tests of significance usually find them difficult to grasp, and they will welcome the thoroughness with which the arguments here are driven home. Similarly, it is very helpful to find examples illustrated by more than one table, showing the state of affairs at successive stages in the calculations. The corollary of this unhurried approach is that the range of topics covered in the book is rather restricted. After a number of chapters on descriptive methods the reader is introduced to the idea of sampling, and led on to tests of significance of the mean and standard deviation, and the corresponding two-sample problems. The analysis of variance (between and within groups) is presented in the second half of a chapter on the variance ratio; here the reader may not fully realize that the problem really concerns differences in means rather than variances. Finally, there are chapters on the binomial and Poisson distributions and on the use of χ^2 as an index of dispersion and for testing goodness-of-fit. Thus, there is no treatment of contingency tables, and no mention of bivariate problems. The book is, in fact, accurately described by its title, being intended as an instructor in first principles rather than as a reference book for a wide variety of techniques. As such it is most successful.

There seem to be very few typographical slips. On pages 92 and 93, odds of 18 to 1 and 2 to 1 against obtaining a more extreme result than that observed are disconcertingly given as odds *for* this event. One or two points in the exposition call for comment. In an early chapter the identity $s^2 = \Sigma x^2/n - \bar{x}^2$ is given. Later, in performing the t-test the reader is instructed to obtain the "sample variance" by multiplying s^2 by $n/(n-1)$. Eventually, in the section on the analysis of variance the customary identity for the sum of squares about the mean is introduced. It is surely more economical, and less confusing, to introduce the latter identity in the first place. Secondly, many readers will be surprised to find no mention of the phrase "standard error". This is a pity, not only because the term is so widely used that the learner will want to know what it means, but also because the standard deviation of a theoretical sampling distribution is different conceptually from that of a finite number of observations, and there seems to be no harm in giving it a special name. In view of the limited scope of the book, it is rather surprising to find a chapter devoted to skewness and kurtosis. These concepts must certainly be discussed, but the scientist is unlikely to see the relevance to his experimental problems of the detailed instructions for the calculation of b_1 and b_2.

The Poisson distribution is presented as a limiting form of the binomial. The limiting process required to obtain the Poisson distribution in this way for random events in time or space is not at all clearly described, and one would have thought it preferable, and more accurate, to state that for this type of phenomenon (e.g., emissions of radioactive particles) the Poisson holds good in its own right, rather than as an approximation to the binomial. Incidentally, the author says on p. 213 that she has not come across a distribution with a significantly smaller scatter than the Poisson. One might instance the counting of red blood cells; if the density of cells is sufficiently high there will be an effect of "negative contagion," due to the slipping away from each other of cells which otherwise would overlap. For a given mean, therefore, the distribution of the number of cells per square will have a deficit of squares with very high, and of those with very low numbers of cells (Lancaster, *J. Hyg., Camb.*, 1950, **48**, 402).

P. ARMITAGE.

4.—*Introduction to Statistical Science in Agriculture.* By D. J. Finney. Edinburgh: Oliver & Boyd, 1953. 179 pp. 10″. 25*s*.

In spite of the large number of elementary text-books in statistics, very few provide a suitable introduction for agricultural and forestry students. Dr. Finney's book provides a very welcome addition to these.

Those who have lectured to agricultural students, as Dr. Finney has during the past seven years at Oxford, will appreciate the problem of providing an adequate introduction to statistics in eight or ten hours' lecturing time. The question of which aspects of statistical method to

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

emphasize and which to omit needs to be carefully considered if the beginner is not to be overwhelmed with a mass of detail; such detail usually leads to the misinterpretation and misapplication of statistical techniques.

In presenting this book, which developed from his lectures, Dr. Finney has adopted a scheme of presentation which students approaching statistics for the first time should find very useful. He emphasizes the principles of statistics so that the student shall understand the purposes that it can serve and know when statistical method is appropriate to any problem. Algebraic and arithmetic detail are consequently minimized and, in Dr. Finney's words, "Nevertheless, I am here much less concerned that my readers shall learn to make a *t* test, or to calculate a standard error of sampling, than that they should appreciate the advantages of careful choice of experimental designs, the chief features of a good sampling investigation, the need for objective statistical analysis of data, the logical basis of significance tests, and related topics."

This objective is achieved in a clear and detailed account that is full of useful practical examples and advice to the agriculturist. There are nine chapters dealing with significance tests, probability distributions, experimental designs, sampling, regression and correlation. The book concludes with a valediction consisting of twelve rules, which, if followed, would save much needless work and simplify the presentation of any that is performed.

Only one thing about this book seems to be unfortunate; that is the price. Although twenty-five shillings is not very much for a book nowadays, it is high for an introductory text of only 179 pages. It would be a pity if students were discouraged from reading this book by its price.

M. H. QUENOUILLE.

5—*Field Experimentation with Fruit Trees and other Perennial Plants.* By S. C. Pearce. (Technical Communication No. 23 of the Commonwealth Bureau of Horticulture and Plantation Crops.) Farnham Royal: Commonwealth Agricultural Bureaux, 1953. x + 131 pp. 9¾″. 10*s*.

Dr. Pearce describes his book as the expression of a continuing tradition. It is the tradition of methods of designing and analysing experiments which is associated with East Malling Research Station and which is founded on experiments carried out there for thirty-five years (statistically designed for twenty-five of them), and on discussions and correspondence with research workers on perennial plants in many parts of the world. Most of the methods have already been described in papers scattered over many journals; but here they are brought together and presented systematically, together with a critical review of the contributions of other workers in this field.

The word tradition is emphasized to make it plain that this is not "just one more" of the multitude of books on the design and analysis of experiments, but that it presents a distinctive viewpoint. Because of this the book may be read with profit by those who design, analyse or conduct trials with other material than perennial plants. Principles are kept in the foreground, and we all need to be reminded from time to time that while holding firmly to principles we must adapt their practical application to the problem in hand. Dr. Pearce shows how successfully they have been adapted to the awkward problems presented by fruit trees.

It must be added that the tradition is not dead but very much alive. It is remarkable how great a proportion of the book describes methods and ideas developed since the war.

A short introductory chapter is followed by five on the design of experiments. The close relation between methods and materials is here made plain. The longevity of fruit trees, combined with the liability of individuals to accidents or disease, makes desirable simple designs which will not be greatly affected by losses. As variation is often due to differences between trees rather than between their positions, little space is given to confounding. The probability that the original treatments will have shown their relative merits long before the trees are too old for use makes provision for changing treatments desirable. The discussion of the best size, shape, and number of plots contains much practical wisdom. A catalogue of uniformity trials with perennials is given here. Dr. Pearce puts plainly his case against the uncritical use of these trials to determine *the* optimum plot size for a species, and suggests that their value lies rather in indicating the general level of variability and the relations between different measurements.

Two chapters on the analysis of data include an interesting discussion of the purpose of calculating significant differences, when an *F*-test has shown that there are some real differences between treatments. It is suggested that the experimenter must then conclude that each pair of treatments differ, but that he has not demonstrated this if their means differ by less than the significant difference. This is sounder statistically than the conventional conclusion that the pair of treatments do not differ in such a case, but it is less sound psychologically for an over-enthusiastic experimenter. Another subject on which opinions vary is the testing for significance of the many

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

interactions in a multi-factorial experiment. If each is tested separately there is a high probability that at least one will appear to be significant at the $P = 0{\cdot}05$ level, even if there are no real effects. Dr. Pearce's suggestion is that certain effects (usually the main effects and two-factor interactions) should be "nominated" at the start of the experiment and that they should be tested separately. The degrees of freedom and sums of squares of all other effects should be pooled to give a single test. Only if this shows significance would those effects be investigated separately.

More records are required with perennials than with annuals, and many of them can only be obtained by sampling or by estimation because of the size of trees and the bulkiness of their crops. The last chapter discusses the requirements which records must satisfy if they are to be useful, and states which measurements have been found desirable on fruit trees.

Four appendices describe computation in general terms, but no attempt has been made to give a full account of this for every design described. Appendix III is valuable in setting out in full detail, apparently for the first time, the general method (by fitting parameters) of computing the analysis of variance for any valid design. This is occasionally needed for non-orthogonal designs which cannot be regarded as orthogonal ones with a few missing plots to be estimated.

This review has been written chiefly for those to whom the book is not primarily addressed, so that they may see what bearing it has on their problems. The book is addressed to practical experimenters with perennial plants. They should certainly read it. It will not provide them with a ready answer to all their problems, but it will indicate the principles which they ought to apply. They will find that some statistical knowledge is assumed, and if they do not possess this they will have to consult elementary general text-books (a list of suggested ones would be a useful addition in any future editions). They will find the effort worth while.

J. TAYLOR.

6.—*Statistical Tables and Problems.* By Albert E. Waugh. 3rd ed. New York, London [etc.]; McGraw Hill, 1952. xiv + 242 pp. 9″. 25*s.* 6*d.*

The first part of this book contains 35 tables which are claimed to be useful to a student of statistics and the more advanced worker. They can be divided into 4 classes.

1. *Mathematical tables.*—There are 12 tables of the common mathematical functions. Their scope and accuracy are best displayed in the following table.

Table No.	*Function*	*Range and Interval*	*Accuracy*	*Number of Pages*
A5	Squares	100(1)999	Exact	2
A6, 7	Square roots	10(·1)100(1)999	4 s.f. No Δ	4
A8	Reciprocals	1·00(·01)9·99	4 s.f. No Δ	2
A14	Common logarithms	1·000(·001)2·000(·01)999	4 d.p. Mean Δ	4
A15		1·000(1)10,000	5 d.p. No Δ	18
A34		2 (primes) 499	10 d.p. No Δ	1
A32	Logarithmic factorials	1(1) 100	5 d.p. No Δ	1
A16	Natural logarithms	1·00(·01)10·00	4 d.p. Mean Δ	2
A17	$\sum_{m=1}^{n} m^r$	n: 1(1) 40 r: 1(1) 6	Exact	1
A18	$\sum_{m=1}^{n} (2m-1)^r$	n: 1(1) 40 r: 1(1) 6	Exact	1
A27	sin, tan, cot, cos	0°(½°) 45°	3 d.p. No Δ	1

The extensive tables of logarithms indicate that the use of calculating machines is not intended for students using this book. These tables are adequate both in range and accuracy except for the trigonometric one which is rather skimpy. The sums of powers (A17, A18) are a useful addition the reviewer has not seen before in tables for statisticians. It is a pity that these tables are scattered about and not kept together in one part of the book.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2. *Tables of transformations used in statistics.*—There are 7 tables in this class.

Table No.	*Function*	*Range and Interval*	*Accuracy*	*Number of Pages*
A13	$\sqrt{p(1-p)}$	000(·001)0·500	4 d.p.	1
A19	$\sqrt{1-r^2}$	·000(·001)1·000	3 d.p.	2
A11	$Z = \frac{1}{2}\log_e \frac{1+r}{1-r}$	000(·001)0·999	4 d.p.	2
A12	$r = \tanh z$	·00(·01)3·00(·5)6·5	5 d.p.	1
A22	e^{-A}	00(·01)5·00(·1)11·5	4 s.f. (3 at tail of table)	2
A9	$1{\cdot}4826022x$	1·00(·01)9·99	4 s.f.	2
A10	$x/1{\cdot}4826022$	1·00(·01)9·99	4 s.f.	2

Of these the first four need no comment. Table A22 is introduced for generating the Poisson distribution of mean A from the proportion in the empty class. For large A the number of figures quoted is totally inadequate.

The last two tables may intrigue the younger statistician. These are the conversion tables from standard error to probable error and vice versa. The provision of a table to save a multiplication (or a set of multiplications) which could be performed more quickly on a machine than the table could be consulted, may seem surprising, but this cause of surprise fades into insignificance compared to that caused by the existence of a school of thought that in this day and age can see any merit in probable errors.

3. *Tables of probability distributions.*—There are 10 tables in this class.

Table No.	*Distribution*		*Range and Interval*	*Accuracy*	*Number of Pages*
A2	Normal	Frequency	0·00(·01)3·00(·5)5·0	5 d.p., 4 s.f.	1
A1	Normal	Cumulative $\int_0^x$	0·00(·01)3·00(·5)5·0	5 d.p., 7 d.p.	1
A20	Normal	„ $\int_x^\infty$	0·0(·1)10·0	3 s.f.	1
A21	Normal	„ $2\int_x^\infty$	0·0(·1)10·0	3 s.f.	1
A4	Pearson Type III	Frequency	x: 3·65(·05)2·00(·1)4·0(·2)6·6		1
A3	Pearson Type III	Cumulative	α_3: 0·1(·2)1·1	4 d.p.	1
A23	χ^2		χ^2: 1(1)30(10)70 n: 2(1)10	6 d.p.	3
A24	χ^2	Critical table	P: 0·01, 0·02, 0·05, 0·1(·1)0·5 and complements n: 1(1)30	4–5 s.f.	1
A26	t	„ „	P: 0·01, 0·02, 0·05, 0·1(·1)0·9 n: 1(1)30	3 d.p.	1
A25	F	„ „	P: 0·01, 0·05 n_1: 1(1)8(2)16(misc.)100 n_2: 1(1)30(misc.)1,000	3 s.f.	2

The critical tables will be familiar to British statisticians as those in Fisher and Yates and Snedecor. The χ^2 table is Elderton's. The provision of an accurate table of the cumulative normal and a less accurate one over a greater range are welcome, but to give two tables, one for a single tail and one for both tails, seems a little extravagant.

In Tables A3 and A4 α_3 is the normalized moment measure of skewness. No exact formula of what is tabulated is given and this is a criticism of all the tables. The contents have to be deciphered from a mass of descriptive matter.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The author mentions in the preface that A3 and A4 are condensed from a paper by Salvosa written in 1930 and published in book form for the first time. Perhaps the reason for this is that no one has yet found a use for them.

4. *Miscellaneous tables.*—The remaining 6 tables consist of a perpetual calendar, a table of the Julian Day, the values of α_4 for rectangular and point-binomial distributions with a finite number of classes, the Greek alphabet and useful constants. There is a short list of random numbers grouped as 4 digit numbers.

The introductory matter on these tables is very brief, and in many cases only gives the procedure for reading the table.

The tables are very clearly printed, but the small size of the page and the attendant small print would make their constant use rather trying. They have for the most part been copied from other sources without resetting the type, and the profusion of different lay-outs and different meanings of the same headings in different tables will not help the user.

The second part of the book lists a collection of formulae. Many of these are of the kind "Mode = 3(median) − 2(mean)". And it seems positively dangerous that these rules should be given without any descriptive background or cautions about the circumstances of their validity. Of the 137 formulae given, the above remarks apply to at least a third. Another third are merely definitions, and the last third very much abbreviated rules for common statistical calculations. Such "potted" information can be very dangerous and the book would be better without it.

Whatever criticisms there may be of the first parts of this book the last part more than justifies its publication. This consists of an enormous list of exercises and problems all based on real data.

Most teachers of statistics will know how difficult it is to obtain realistic data for our students that is at the same time of manageable proportions. These exercises solve that problem for us for all time. The data range over human biology, sociology, economics, history, chemistry and many other topics, and illustrate the use of graphical representation, the description and fitting of distributions, the measure and detection of correlation and association and the fitting of regressions, simple and multiple.

As if the provision of this store of numerical examples were not enough, the exercises also include examples of the need for clear thinking about the interpretation of results as well as obtaining them.

The author firmly declares his belief in the absolute need for practical work by the student statistician as the only way to give him an understanding of masses of figures. These exercises are admirably suited to that purpose.

As an example of the detail of the exercises, there is a whole set on the meaning of significant figures, of which the following is typical:

> "A man wishes to determine the diameter of a steel water tower . . . he finds its circumference is 1084 inches . . . Assuming the tower is circular, what is the most accurate estimate of the diameter he can make? ($\pi = 3{\cdot}14159265359$)."

By such homely examples all the practical difficulties of the statistician's art are introduced to the student.

The relatively high price of this book will preclude many students from buying it but it is a "must" for every teacher of the subject.

K. D. TOCHER.

7.—*Methods of Statistical Analysis in Economics and Business.* By Edward E. Lewis. Boston, New York: Houghton Mifflin, 1953. viii + 686 pp. 9¼". $5.50.

This book is written by a University teacher of statistics, assisted by his wife, who is an experienced teacher of mathematics, and it is modestly described as a first course in statistics. Although it assumes no mathematical knowledge beyond an acquaintance with arithmetic and elementary algebra, it covers all the main applications of statistics in a practical manner, which should be readily acceptable to the accountant, the commercial manager, the economist and the factory manager who may wish to learn something of the more advanced techniques delegated to a specialist. A selection of its chapters would provide an excellent text-book of statistics for accounting and other professional examinations in statistical method, subject to the qualification that all quoted sources are American, and its more advanced sections will form a useful volume of supplementary reading and exercises for the intermediate and final degree or professional statistician with particular reference to the applied (general) sections of his syllabus.

There are six parts each containing two or three chapters: the chapters are each divided into several sections, self-contained lessons with their own exercises. The introductory part is in itself fairly comprehensive, and its 94 pages alone contain much that ought to be known (but is often forgotten) by candidates in those professional examinations which take elementary statistics

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

in their intermediate examination. It also provides a digestible and practical hors-d'oeuvre for those who intend to specialize, and an antidote for those who are attracted to the subject largely by its mathematics. The student who answers correctly at his first reading all the exercises in this first section will make something of his career, but he will probably answer them in another way when he has finished his course.

The second part deals with averages, measures of dispersion, relative skewness and kurtosis. Unlike some introductory books, the mode, median and other partition values are briefly, clearly and precisely explained. The geometric mean and an explanation of where its use is appropriate are covered in $4\frac{1}{2}$ pages of clear teaching. The concept of dispersion is first explained by a few examples and, having shown us how to use the standard deviation, the author gives us an excellent non-mathematical picture of the Gaussian normal distribution. Discussion of the relation of mean and mode leads semi-automatically to the meaning of skewness, and this part of the book concludes with a concise section on kurtosis and the mechanical parallel of moments—ideas to be well founded on a couple of simple diagrams.

Part three concerns *Statistical Inference*, and begins with a chapter on the use of sample information, the estimation of the true mean and inference from small samples. Next we have a chapter on significant differences which contains one of the most readable introductions to the analysis of variance ever written. This part also contains a *t*-table abridged from Fisher and Yates (by permission of Oliver & Boyd), and a table of the variance ratio *F* based on Snedecor's table, where two founts of type are used to express the 1 per cent. and 5 per cent. significance levels on adjacent lines. So that the student may use these tests intelligently, some care is devoted to the explanation of the null hypothesis and its prior assumption in each example demonstrated. The seventh chapter covers miscellaneous types of inference, mainly from data divided into two classes leading to the binomial expansion, the standard deviation of large sample means, the chi-squared distribution (the table is from Fisher and Yates) and quality control. Mr. and Mrs. Lewis are to be congratulated on thus making the many technical developments of the last twenty years comprehensible to the ordinary man.

Index Numbers are the subject of part four. It is mainly here that the American sources quoted may be something of an embarrassment to the British Commonwealth student. The reviewer liked the logical process of building up an index with weighted price relatives. Following this the aggregative index is proved to be the same as the weighted index, and the chapter concludes with practical problems of construction. A few applications of index numbers to measurement of real income, import and export prices, and changes of physical volume of goods complete this section.

The penultimate part deals with *Time Series Analysis*, and these 114 pages form yet another section which might have been published as a monograph on its own. Again there are plenty of examples and exercises. The use of polynomials to represent a non-linear trend is demonstrated with a logarithmic transformation, but this is not over-done, and the author reverts to moving averages and simple ratios for measuring seasonal and cyclical fluctuations.

Part six on *Correlation* is introduced diagrammatically, and we are thus enabled to meet the correlation ratio (as a measure of goodness of fit) before we meet the correlation coefficient. The null hypothesis is again introduced as an indispensible step in correlation of samples, leading to the *Z* transformation. The Doolittle method for solving symmetrical normal equations is demonstrated by an example. A section on rank correlation is followed by one on the systematic calculation of partial correlation coefficients using a columnar layout similar to Yule and Kendall (section 12.16). We are not allowed to leave this subject without a further application of the null hypothesis and variance test for multiple correlation.

The Appendix contains tables of logarithms, squares and square roots (of three significant figure numbers) and a bibliography of 30 books for supplementary reading, which includes *Statistical Methods for Research Workers* and Yule and Kendall as the distinguished but sole representatives from this side of the Atlantic. The purely statistical tables are in the chapters near the examples. Certain basic formulae are conveniently scheduled in the Appendix and there is a comprehensive index.

The serious student of statistics will not be able to use the book alone because it contains very little in the way of mathematical justification. Some teachers may suspect that occasionally the cart comes before the horse, but a rearranged sequence of recognitions must be expected in a supersonic age. All final students should endeavour to borrow the book for vacation reading, and those of us who graduated more than 15 years ago may find it a pleasant volume for revision if our mathematical mill has rusted from disuse. It is a volume which most teachers and most practising statisticians would like to have on their shelves: it will also do much to spread a knowledge of the science of statistics to those members of the English-speaking community who never hope to understand mathematics.

HAROLD GEARING.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

8.—*An Introduction to Statistical Calculations.* By J. Mounsey. London: English Universities Press, 1952. xi + 351 pp. 7¼″. 15*s*.

From the preface we learn that this book "is designed primarily for students in Commercial and Technical Colleges who are preparing for a wide range of examinations, and for the use of lecturers on statistics in such institutions". As indicated by its title, the theme of the book is not statistical theory but statistical calculations, and one immediately thinks of somewhat similar works by Chambers and Shepherd Dawson. But these should be regarded as complementary rather than supplementary by reason of their different fields of emphasis.

Those who have had dealings with students of this subject—particularly students attending evening classes—will know that one of the main barriers to a closer appreciation of the methods of statistics is the difficulty of obtaining even the minimum amount of practical work. Various reasons are advanced for this but no longer will it be valid to plead the lack of material. The theme of Mr. Mounsey's book is developed in terms of some 230 worked examples with explanatory notes, together with nearly 600 exercises with answers upon which "the reader may thoroughly test his progress and so gain confidence and facility in computation". A brief survey of the contemporary literature at an elementary and intermediate level shows that, in addition to Mr. Mounsey's new collection, there are, for example, some 320 exercises in *Yule & Kendall*, 410 in *Brookes & Dick* and 300 in *Dixon & Massey*, to say nothing of *Butterbaugh's* "1001 Questions in Elementary Statistical Analysis". Most of these books, too, have examples worked out to illustrate the various portions of text material and some have answers to their exercises. These considerations are important because they lead to what this reviewer believes to be the central issue as far as this new book is concerned. In trying to help the student and others to overcome the various hazards of statistical calculations, Mr. Mounsey has come very close to producing a book which is neither a useful textbook with examples and exercises—an aim which he disavows—nor a straightforward collection of examples and exercises for use with a textbook. The style of the book grows more like a textbook as the pages are turned. For example, the note on skewness at the end of Chapter V contains nothing on statistical calculations, and as a note on measures of skewness it is both inaccurate and incomplete. This general view may be made clearer by reference to some further points of detail: The introduction of the median in the last paragraph of p. 18 before it is formally dealt with on p. 19 could have been avoided by rearrangement. Why should not the general name "quantiles" (p. 22) be used as the heading for the section instead of being relegated to a sentence at the bottom of p. 23? On p. 26 the concept of a "Skew distribution" is introduced before any treatment of Histograms and the Mode which (on p. 29) form a natural introduction to this idea. On p. 56 another chance to explain the difference between a moving average with equal weights and one with unequal weights appears to have been missed. The use of the method of summation (p. 146) might well have been left to the section dealing with factorial moments (p. 199). The heading for the section on p. 148 would probably mean more to the student if given as "Standardisation of Variate" rather than "Adjustment of Examination Marks", which is but one example of the use of this basic operation. It would also avoid leading the elementary student too close to the tortuous paths of statistical methods in psychology and educational testing. The sections on "Moments of a Continuous Distribution" and "Moment Generating Functions" (pp. 203 and 247) are not necessary for the examinations listed in the preface and seem to go beyond the general scope of the book. The heading "Two Factor Analysis" (p. 287) in connection with analysis of variance may raise difficulties *vis-à-vis* Two Factor Analysis as part of the general factorial methods of analysis. The more usual "two criteria of classification" would have avoided this. The brief reference on p. 288 to a factorial design involving three factors and their interactions is not sufficiently differentiated from the detailed treatment of the Latin Square analysis which is styled "Three Factor Analysis", but which, of course, cannot have any calculations for interaction.

None of these points is so fundamental that it cannot be easily dealt with in a later edition, and it should be remembered, these are the reviewer's present opinions and time may well show that some of his fears are groundless.

The practical question with Mr. Mounsey's book, as with most others, lies in the realm of student economics. Can the ordinary student—for whom the book is intended and for whom the subject of statistics may be only one of many needing attention—be expected to acquire a good textbook and then a book of examples and exercises involving a considerable cash outlay. The book deserves the most serious consideration by all who teach statistical methods at the elementary or intermediate levels and by those who, from time to time, have the task of advising students and others upon the bewildering array of current literature in this subject, but it may well prove to be of greater benefit to the teacher than to the student, and it is suggested that a student should be recommended to use it only where it is known that a good text is already available.

W. R. BUCKLAND.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

9.—*Table of Arctan X.* 2nd ed. National Bureau of Standards; Applied Mathematics Series, 26. Washington, 1953. xiii + 171 pp. 10″. $1.75.

As part of the activities of the Works Progress Administration, a New York Mathematical Tables Project was formed in 1938, under the scientific sponsorship of the National Bureau of Standards, and directed by Arnold N. Lowan. From the first, the Project was in continuous communication with the British Association Mathematical Tables Committee, who were consulted about their proposed plan of campaign. With the resources open to the Project many volumes of mathematical tables soon began to make their appearance. The volume under review was one of these, and was first published in 1942. The Introduction was by Arnold N. Lowan, but an interesting Foreword was contributed by W. G. Bickley, long a member of the B.A. Committee, and at present a member of the Royal Society's Mathematical Tables Committee. This was a monumental undertaking, for the function $\tan^{-1} x$ is given to 12 decimal places for x (in radians) ranging from zero to 10,000, the interval being 0·001 up to $x = 7$, widening out gradually until it becomes 10 between 2,000 and 10,000.

Several misprints in this first edition have now been corrected, but otherwise no major revision has been undertaken in the present (photo-offset) edition. The volume is issued as one of the Applied Mathematics Series of the National Bureau of Standards. The successor of the original Mathematical Tables Project is now, in fact, the Computation Laboratory of the NBS National Applied Mathematics Laboratories, established in 1947, and well known for other activities besides the continuous production of volumes of useful mathematical tables.

The figures are very clearly printed, and second differences are provided. These enable interpolation to be carried out with Everett's formula within an accuracy of 1·5 units of the twelfth decimal place. For the less exacting user it should be pointed out that linear interpolation is correct to 6 decimal places everywhere. A supplementary section contains two conversion tables, to convert radians to degrees and degrees to radians. The bibliography of tables of $\tan x$ and $\tan^{-1} x$ (and related functions) has been brought up to date. J. WISHART.

10.—*The Practice of Life Assurance.* By N. E. Coe, F.I.A., and M. E. Ogborn, F.I.A. Cambridge University Press, 1952. x, + 440 pp. 8½″. 32*s*.

This book is one of a series of students' text-books commissioned by the Institute and the Faculty of Actuaries, and one may expect to find an actuarial bias in its contents. For this reason, perhaps, the title is unfortunate. "Practice", one would suppose, should include such matters as means of obtaining new business, organization, accounting, titles to policies, etc. In fact the scope is "all those practical applications of" actuarial "theory . . . which are the concern of the life office actuary".

There are three parts, styled respectively "General", "Ordinary Life Assurance" and "Industrial Assurance". The first part contains an excellent review of general principles, an historical review and chapters on law, investments, tax, valuations, and the effects of war. These support what is perhaps the most important chapter of the book, "The Elements", in which are discussed the factors on which the major actuarial decisions in an office depend.

In Part II the general principles discussed in Part I are applied to the problems of ordinary life assurance. Though there are some good chapters and passages, notably a chapter on underwriting and extra risks, there is also much tedious plodding through details. Much of this may be necessary: theory and practice do not always agree, and in a book of this type the divergences should be discussed. Yet at times one cannot see the wood for the trees, and may wonder if it would not be better to leave the student to do some thinking and research for himself.

If the second part is a catalogue of trees, the third is a sketch map of a forest. Though there is a proper actuarial bias, the part serves as a useful layman's introduction to industrial assurance, and practical points are emphasized as nowhere else. Statisticians may be interested in outline descriptions of the methods used in handling records comparable in size and complexity with the Census, but constantly changing and continuously maintained.

Some minor faults of the book have been noted above; it has one major one, lack of balance, of which the amounts of detail in Parts II and III provide one example. The inadequate treatment of pension schemes—from which more than half of the new ordinary premium income of life offices is derived, and which exhibit many peculiarities of practice—is another; they are dismissed in less space than "Model Offices", a technical actuarial tool of limited use. A virtue is that much of the book is written in clear good English, not algebra; actuarial formulae are only introduced when necessary. And the book is enriched by many references to practice in other lands: they help to re-establish the distinction between the essential and the accidental.

In default of an adequate non-technical book on the subject, this is a book which the interested layman will find useful; by skipping much, but judiciously, he will acquire an understanding of the basic techniques of a major financial service. M. D. W. ELPHINSTONE.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

The interim index of retail prices published by the Ministry of Labour and National Service which stood at 140 (prices at June 17th, 1947 = 100) in March, 1953, rose to 141 in April and fell back to 140 in May. The rise in April was mainly due to increases in local rates and to higher prices for vegetables, flour and tea. The subsequent fall was accounted for by seasonal reductions in the prices of coal and milk and by reductions in the case of many appliances, floor coverings, etc., caused by a decrease in the purchase tax. Separate figures on the same basis for different groups of commodities are not available, but the following are the figures based on January 15th 1952 = 100:

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*Household Durable Goods*	*Miscellaneous Goods*	*Services*	*Alcoholic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
March 17th, 1953	110·7	104·4	95·6	107·2	97·4	102·5	107·4	101·0	100·3	105·4
April 14th, 1953	112·5	108·2	95·6	107·7	97·3	102·5	107·5	101·0	100·3	106·4
May 12th, 1953	112·7	108·4	95·6	104·7	94·9	100·0	107·6	101·0	100·3	106·0

The Ministry of Labour index of weekly wage rates which was 135 in March remained at that level in the next two months. Certain sections of workers received increases during the period but these were insufficient to affect the overall average level calculated to the nearest whole number.

The total working population and the numbers in civil employment in February, March and April, 1953, were as follows:

(*Thousands*)

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
Feb., 1953 . .	15,870	7,406	23,276	14,771	7,244	22,015
March, 1953 . .	15,851	7,403	23,254	14,776	7,251	22,027
April, 1953 . .	15,867	7,441	23,308	14,814	7,295	22,109

The number of persons on the unemployment registers of the Employment Exchanges fell by over 20,000 in April and by a further 35,000 in May.

The following is a sex analysis of the figures:

Numbers of Unemployed Persons on the Registers of Employment Exchanges

Date	*Men and Boys*	*Women and Girls*	*Total*
March 16th, 1953	251,134	145,904	397,038
April 13th, 1953	239,413	136,393	375,806
May 11th, 1953	214,263	125,990	340,253

Of the total of 340,253 at May 11th, 23,540 were temporarily stopped, 86,256 had been unemployed for not more than two weeks, 77,509 from two to eight weeks and 152,948 for over eight weeks.

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employees, were 1,043,500 in March, 945,900 in April and 881,700 in May. The numbers of employees absent owing to industrial injury were 63,300, 58,500 and 59,400.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In the June issue of the *Ministry of Labour Gazette* figures are given of the age and regional analysis of the numbers of employed persons in 1952, based on a 1 per cent. sample of the insured employees. The age analysis shows that 7 per cent. of the male employees were under 20, 44 per cent. 20 and under 40, 45 per cent. 40 and under 65 and 4 per cent. 65 and over. In the case of females 17 per cent. were under 20, 45 per cent. 20 and under 40, 34 per cent. 40 and under 60 and 4 per cent. 60 and over. Figures for three successive years relating to males at each year of age above 60 and for females from 18 to 28 show the rate of depletion. The proportion of married women amongst female employees is shown to be 44 per cent., the proportion ranging from 3 per cent. of those under 20 to 68 per cent. of those 35 to 39. The regional analysis of the figures contains estimates of the inter-regional migration. The London and South-Eastern region had the largest inward migration.

CURRENT NOTE.

The Trustees of the Houblon-Norman Fund, on the recommendation of their Advisory Committee, have made the following awards for 1953/54.

Fellowship.—Mr. E. W. J. Kerridge, Houblon-Norman Fellow, 1952/53 (renewal), "The History of Ley Farming, particularly in Midland England, in the XVI, XVII and XVIII Centuries."

Research Grants.—Mr. D. Barker, Bank Official, "English Investment Trusts"; Mr. D. J. Darby, Bank Official (Renewal), "The London Banks in the Bank Restriction Period"; Mr. G. F. Hammersley, Research Student, University of London, "History of the Charcoal Iron Industry in England, 1550/1750"; Mr. M. J. Harper, Bank Official, "Joint Stock Banking in London, 1890/1914"; Mr. R. J. Hartridge, Teacher, South London Secondary Central School (Renewal), "The Development of Industry in London South of the Thames from 1750/1850"; Dr. G. P. Insh, C.B.E., D.Litt., Historian (Renewal), "The Financial Activities of William Paterson"; Mr. R. V. Lennard, Historian, "Rural England in the Feudal Age"; Mr. P. Mathias, Jesus College, Cambridge, "The Organisation and Development of the Brewing Industry in England, 1688/1830"; Mr. H. Pollins, Senior Research Assistant, University College of Swansea, "British Railway Finance, 1800/1875"; Mr. R. O. Roberts, Lecturer, University College of Swansea, "The Marketing and Purchasing Organisation of the Copper Smelting Industry of South Wales in the XIX Century"; Mr. A. J. Taylor, Lecturer, University College, London (Renewal), "Organisation of the British Coal Industry, 1800/1875"; Mr. F. M. L. Thompson, Assistant Lecturer, University College, London (Renewal), "The Social and Economic Background of the English Landed Interest, 1840/1870"; Mr. T. Wilson, Fellow of University College, Oxford, "Economic Fluctuations in the United Kingdom between 1923 and 1938."

An offer of awards for 1954/55 will be made early in 1954. Further information may be obtained from the Secretary, Houblon-Norman Fund, c/o Bank of England, London, E.C.2.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

April 1953—The capital error: *P. N. Wallis.* An accounting progression: *F. Sewell Bray.* The economic and accounting concepts of profit: *A. G. Pool.* The construction and presentation of social accounts: *R. L. Mathews.*

Advancement of Science—

March 1953—Location of industry in Northern Ireland: *W. Smith* and *B. J. Ahern.* Road accidents: *R. J. Smeed* and *R. L. Moore.* Problems of old age: *G. F. Adams, A. V. Hill* and *A. T. Welford.*

Agricultural Economics Society, Journal of Proceedings—

February 1953—The farmer in business: *A. W. Ashby.* Distribution of farm income in the United Kingdom, 1867–1938: *J. R. Bellerby.* Food and money: some reflections on changes in food consumption and farm prices: *E. M. H. Lloyd.*

Annals of Eugenics—

April 1953—Quantitative aspects of the blood-group antigen Fy^a: *R. R. Race, R, Sanger* and *D. Lehane.* The linear function maximising intra-class correlation: *C. A. B. Smith.* The sampling variances of some statistics used in univariate discrimination: *R. S. Krooth.*

June 1953—The blood factor *C* of the *A–B–O* system, with special reference to the rare blood group *C*: *A. S. Wiener.* Changes in body weight from 1943 to 1950: *W. F. F. Kemsley.*

Biometrika—

June 1953—The superposition of several strictly periodic sequences of events: *D. R. Cox* and *W. L. Smith.* Approximate confidence intervals: *M. S. Bartlett.* Incomplete and absolute moments of the multivariate normal distribution with some applications: *A. R. Kamat.* On the range of partial sums of a finite number of independent normal variates: *A. A. Anis* and *E. H. Lloyd.* Note on "The Jacobians of certain matrix transformations useful in multivariate analysis": *I. Olkin.* Estimation of a functional relationship: *D. V. Lindley.* Estimating parameters in truncated Pearson frequency distributions without resort to higher moments: *A. C. Cohen, Jr.* A problem of inference between two queues: *J. C. Tanner.* Tables of the angular transformation: *W. L. Stevens.* Tests of significance in a 2×2 contingency table: extension of Finney's table: computed by *R. Latscha.* A method for judging all contrasts in the analysis of variance: *H. Scheffé.* The estimation and comparison of strengths of association in contingency tables: *A. Stuart.* A sequential test for randomness: *P. G. Moore.* On the mean successive difference and its ratio to the root mean square: *A. R. Kamat.* The effect of unequal group variances on the *F* test for the homogeneity of group means: *G. Horsnell.* The estimation of population parameters from data obtained by means of the capture-recapture method. III. An example of the practical applications of the method: *P. H. Leslie, L. Chitty* and *H. Chitty.* On the utilization of marked specimens in estimating populations of flying insects: *C. C. Craig.* The total size of a general stochastic epidemic: *N. T. J. Bailey.* Experimental evidence concerning contagious distributions in ecology: *D. A. Evans.* Time intervals between accidents—a note on Maguire, Pearson and Wynn's paper: *G. A. Barnard.* Further notes on the analysis of accident: *B. A. Maguire, E. S. Pearson* and *A. H. A. Wynn.* On a method of estimating biological populations in the field: *C. C. Craig.* A rapid method for estimating the correlation coefficient from the range of the deviations about the reduced major axis: *C. H. Leigh-Dugmore.* The effect of overlapping in bacterial counts of incubated colonies: *C. Mack.* Non-normality in two-sample *t*-tests: *D. G. C. Gronow.* Note on the Poisson index of dispersion: *N. Kathirbamatamby.* On an extension of Geary's theorem: *R. G. Laha.* The Doolittle method and the fitting of polynomials to weighted data: *P. G. Guest.* A simple method of deriving best critical regions similar to the sample space in tests of an important class of composite hypotheses: *K. S. Rao.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

British Journal of Preventive and Social Medicine—

April 1953—Illness during the first five years of life: *R. M. Dykes, F. Grundy* and *E. Lewis-Faning*. The hour of birth: *E. Charles*. Some observations on the heights and weights of undergraduates: *G. Grant* and *R. A. N. Hitchens*. Effect of upper deck temperature on the health of men in ships of the Royal Navy: *F. P. Ellis, F. E. Smith* and *C. R. Underwood*. Proportion of families served by a family doctor: *J. S. Owen*. Weight at third birthday related to birth weight, duration of gestation, and birth order: *C. R. Lowe* and *J. R. Gibson*. Influence of birth order and maternal age on the human sex ratio at birth: *B. Macmahon* and *T. F. Pugh*.

British Journal of Statistical Psychology—

May 1953—A note on Sir Cyril Burt's 'Factorial analysis of qualitative data': *L. Guttman*. Scale analysis and factor analysis: comments on Dr. Guttman's paper: *C. Burt*. Covariance analysis and its applications in psychological research: *N. Gourlay*. The distribution of total rank value for one particular object in m rankings of n objects: *J. W. Whitfield*.

Bulletins on Soviet Economic Development—

May 1953—Post-war economic development in the U.S.S.R. (Whole number.)

Economic Journal—

June 1953—Accumulation, productivity and distribution in the British economy, 1870–1938: *E. H. Phelps Brown*, and *B. Weber*. Foreign exchange rates and monopolistic competition: *H. Brems*. A model of income distribution: *D. G. Champernowne*. Choice in psychology and as economic assumption: *A. L. Macfie*. Notes on user cost: *A. D. Scott*. Wage claims and the pace of inflation (1948–1951): *A. T. Peacock* and *W. J. L. Ryan*.

Eugenics Review—

April 1953—Experimental studies of hereditary influences on behaviour: *R. W. Russell*. Family environment and intelligence: *J. Nisbet*.

Heredity—

April 1953—The variation in strength of the human blood group *P*: *Sir R. Fisher*. The linkage of *polydactyly* with *leaden* in the house-mouse: *Sir R. Fisher*. Statistical models in biometrical genetics: *J. A. Nelder*. Components of variation under sib-mating: *B. I. Hayman*.

Incorporated Statistician—

March 1953—Index number of retail prices: *R. G. D. Allen*. Aspects of random sampling for a commercial survey: *F. Edwards*. The statistical function in a distributive organization: *N. C. Turner*. A note on intensity measurement: *A. Harris* and *L. T. Wilkins*.

Manchester School of Economic and Social Studies—

May 1953—The theory of forward exchange and recent practice: *J. Spraos*. The British Export Trade Research Organization: *J. A. P. Treasure*. Cost-output variations in a multiple product firm: *J. Johnston*. The industrial structure of towns: *F. Conway*. Profits in large scale retailing: *F. R. J. Jervis*.

Oxford University Institute of Statistics Bulletin—

April 1953—The slump in the cotton industry, 1952: *H. A. Turner* and *R. Smith*. Economic developments in 1952 and future prospects: *D. G. Holland* and *D. Seers*. Recent productivity changes in the British cotton industry: *K. S. Lomax*.

May 1953—Convertibility and the European Payments Union: *A. C. L. Day*. Expenditure of Glasgow University students: *J. S. Pattison*.

INDIA—

Sankhyā—

December 1952—Some aspects of the design of sample surveys: *P. C. Mahalanobis*. An extension of Wald's decision theory to unbounded weight functions: *M. N. Ghosh*. Some

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

theories on minimum variance estimation: *C. R. Rao.* An example of non-existence of a minimum variance estimator: *D. Basu.* On symmetric estimators in point estimation with convex weight functions: *D. Basu.* Minimum variance estimation in distributions admitting ancillary statistics: *C. R. Rao.* On a class of admissible estimators of the normal variance: *D. Basu.* On sequential tests of the equality of variances of two normal populations with known means: *S. Rushton.* A property of the *t*-statistics: *R. R. Bahadur.* On some uses of the *t*-distribution in multivariate analysis: *A. Bhattacharyya.* The inverse hyperbolic sine transformation on Student's *t* for non-normal samples: *A. K. Gayen.* Some aspects of stationary time series: *K. Nagabhusanam.* On the estimation of parameters determining the mean value function of a stochastic process: *H. B. Mann.* The estimation of the ED50 for a logistic response curve: *D. J. Finney.* Resolvable balanced incomplete block designs: *E. J. F. Primrose.* On the concept and use of orthogonal semi-polynomials: *C. C. Sekar* and *P. N. Chakraborty.* A statistical study of absenteeism in Indian labour: *M. Chand* and *A. K. Banerji.* Statistical quality control in an Indian manufacturing concern: *A. Mahalanobis.* Report of the Sub-Commission on Statistical Sampling.

UNITED STATES—

American Economic Review—

May 1953—Papers and Proceedings of the sixty-fifth Annual Meeting of the American Economic Association, Chicago, Illinois, December 27–29, 1952. (Whole number.)

Annals of Mathematical Statistics—

March 1953—Distribution-free tests of fit for continuous distribution functions: *Z. W. Birnbaum.* Contributions to the statistical theory of counter data: *G. A. Albert* and *L. Nelson.* The power of rank tests: *E. L. Lehman.* Nonparametric tolerance regions: *D. A. S. Fraser.* Sequential sampling tagging for population size problems: *L. A. Goodman.* On Wald's complete class theorems: *J. Kiefer.* A class of experimental designs using blocks of two plots: *O. Kempthorne.* Distance functions and regular best asymptotically normal estimates: *W. F. Taylor.* On the distribution of the expected values of the order statistics: *W. Hoeffding.* On the theory of systematic sampling, III: Comparison of centered and random systematic sampling: *W. G. Madow.* A modification of Schwarz's inequality with applications to distribution: *S. Moriguti.* A simple method for improving some estimators: *L. A. Goodman.* Joint sampling distributions of the mean and standard deviation for probability density functions of doubly infinite range: *M. D. Springer.* A note on incomplete block designs with row balance: *H. O. Hartley, S. S. Shrikhande* and *W. B. Taylor.* A lower bound for the average sample number of a sequential test: *W. Hoeffding.* Some inequalities on Mill's ratio and related functions: *M. R. Sampford.* On a double inequality of the normal distribution: *R. F. Tate.*

Bell System Technical Journal—

March 1953—A throwdown machine for telephone traffic studies: *G. R. Frost, W. Keister* and *A. E. Ritchie.* Working curves for delayed exponential calls served in random order: *R. I. Wilkinson.*

Biometrics—

March 1953—Laboratory flavor scoring: two experiments in incomplete blocks: *J. W. Hopkins.* Some statistical methods in taste testing and quality: *R. A. Bradley.* Some problems in the design and statistical analysis of taste tests: *D. D. Mason* and *E. J. Koch.* On the uniqueness of the line of organic correlation: *W. H. Kruskal.* Variance of a weighted mean: *P. Meier.* Processing data for outliers: *W. J. Dixon.* The estimation of heritability by regression of offspring on parent: *O. Kempthorne* and *O. B. Tandon.* A note on rectangular lattices: *K. R. Nair.*

Estadistica—

December 1952—Supplement to Vol. X, No. 37—Report on the II Session of the Committee on Improvement of National Statistics, Ottawa, Canada, September 29–October 10, 1952. (Whole number.)

March 1953—Agricultural statistics methods and materials. (Whole number.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Harvard Business Review—

May–June 1953—Analysis of stock ownership: *W. L. Crum.* Executive compensation in small companies: *J. M. Rosow.*

Industrial Quality Control—

May 1953—Installing a quality control system: *J. M. Juran.* The technique of preventing defects: *L. A. Seder.* Statistical cost control in the paper industry: *C. E. Noble.* Probability statistics applied to tax returns: *A. C. Rosander.* Fundamental principles of sequential analysis: *I. W. Burr.* Quality control at Timken-Detroit Axle Company: *J. Rayer, Sr.* The statistical approach to bulk sampling problems: *B. H. Lloyd.*

Journal of Political Economy—

February 1953—On the marginal product of capital and the marginal efficiency of investment: *A. P. Lerner.* Long-term foreign investment and underdeveloped countries: *J. M. Hunter.*

Mathematical Tables and other Aids to Computation—

April 1953—A solution of simultaneous linear equations and matrix inversion with high speed computing devices: *G. G. Bejarano* and *B. R. Rosenblatt.* Error bounds of approximate solutions to systems of linear algebraic equations: *A. de la Garza.*

Milbank Memorial Fund Quarterly—

April 1953—The interplay of noxious agents, stress and deprivation in the engenderment of disease: *H. D. Kruse.* Association of the chronic diseases in the same person and their association with overweight: *J. Downes.* Disability from respiratory illness: *D. Tucher* and *J. Downes.* Some demographic aspects of a rural area in Iran: *M. B. Mashayekhi, P. A. Mead* and *G. S. Hayes.*

Psychometrika—

March 1953—Test reliability and effective test length: *W. H. Angoff.* A least-squares solution for case IV of the law of comparative judgment: *W. A. Gibson.* An analytical solution for approximating simple structure in factor analysis: *J. B. Carroll.* A new status index derived from sociometric analysis: *L. Katz.* A factor analysis of intra-task performance on two psychomotor tests: *E. A. Fleishman.* An application of confidence intervals and of maximum likelihood to the estimation of an examinee's ability: *F. M. Lord.* A revised orthogonal rotational solution for Thurstone's primary mental abilities test battery: *W. S. Zimmerman.*

Quarterly Journal of Economics—

May 1953—The structure of the housing market: *D. M. Blank* and *L. Winnick.* The acceleration principle reconsidered: *R. S. Eckaus.* Toward a general theory of sales tax incidence: *J. F. Due.*

BELGIUM—

Bulletin de l'Institut de Recherches Économiques et Sociales—

May 1953—La Belgique en 1952. (Whole number.)

June 1953—La conjoncture économique de la Belgique: *L. H. Dupriez.*

EGYPT—

L'Egypte Contemporaine—

January 1953—A statistical report on commercial workers and the effect of the minimum wage scheme on their wages: *A. Hussein* and *M. A. Badry.* Newer aspects of location in Egyptian history: *G. E. M. Said.* The national income of Egypt, 1950: *M. A. Anis.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

FRANCE—

Journal de la Société de Statistique de Paris—

October–December 1952—Statistique des tailles et des poids des écoliers: *M. Aubenque* and *P. Thionet*. L'évolution des salaires de 1949 à 1951: *R. Heisch*. Chronique des statistiques bancaires et des questions monétaires: *P. Cauboue*.

January–March 1953—Les conditions de l'équilibre monétaire international: *L. Camu*. La psychologie de l'homme rationnel devant le risque: la théorie et l'éxperience: *M. Allais*.

GERMANY—

Weltwirtschaftliches Archiv—

Vol. 70, Part 1—Die neue Entwicklung in der Landwirtschaft der Vereinigten Staaten und ihre Bedeutung für die Weltwirtschaft: *F. Baade*. Wirtschaftsentwicklung und Konjunkturstabilisierung: *H. Bayer*. Grundlagen der Betriebswirtschaftslehre: *E. Schneider*. Expectations and economic stability: *M. D. Brockie*. Zur Theorie des wirtschaftlichen Wachstums: *G. Bombach*.

HOLLAND—

Statistica—

Vol. 6, No. 3—Variantie-analyse: *N. H. Kuiper*. (Dutch text, English summary.)

ITALY—

Giornale degli Economisti e Annali di Economia—

November–December 1952—Sulla preferabilità: *B. de Finetti*.

Statistica—

October–December 1952—I guadagni individuali e familiari di un gruppo di braccianti del Ravennate (Parte prima): *A. Bellettini*. Dinamica della disoccupazione molisana. La concentrazione nell'avviamento al lavoro: *R. Lenzi*.

Giornale Matematica Finanziaria—

Series III, Vol. X, 1952—Considerazioni tecniche intorno al problema degli alloggi in Italia: *F. Insolera*. Ancora sopra un'espressione generale della riserva matematica mediante i premi naturali: *E. del Vecchio*. Sulle condizioni di equivalenza tra rendite a termini in progressione geometrica: *A. Bruno*.

JAPAN—

Bulletin of Mathematical Statistics—

September 1952—Note on enumeration of 7×7 latin squares: *K. Yamamoto*. On the statistical inferences in finite populations by two sample theory: *H. Uranasi*. Stochastic studies on the atomic bomb casualties: *M. Masuyama*. Convergence of integral and its applications: *M. Izaki*. Successive process of statistical inferences (4): *T. Kitagawa*. Random frequency process: *T. Onoyama*. Minimax estimations: *K. Miyasawa*.

SWITZERLAND—

Schweizerische Zeitschrift für Volkswirtschaft und Statistik—

April 1953—Soziale und wirtschaftliche Strukturwandlungen in den Vereinigten Staaten: *M. Silverschmidt*. Les échanges entre pays à systèmes économiques différents: *A. Masnata*. Strukturwandlungen am Markte der mündelsicheren Werte: *C. Gasser*.

INTERNATIONAL—

International Labour Review—

May 1953—The United Nations and full employment: *A. A. P. Dawson*. The measurement of productivity in state undertakings and public services: *G. Ardant*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part II, 1953, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

United Kingdom. *Board of Trade.* Report of the Cotton Import (Review) Committee. London, H.M.S.O., 1953. 13p. 9½″. 6*d.* Cmd. 8861.

Report to the President of the Board of Trade by the United Kingdom Trade Mission to Venezuela, Colombia, the Dominican Republic, Cuba and Mexico November-December, 1952 ... London, H.M.S.O., 1953. 133p. map. 9½″. 4*s.* 6*d.*

Development Commission. A survey of agricultural, forestry and fishery products in the United Kingdom and their utilisation: June, 1951. London, H.M.S.O., 1953. vi, 141p. maps. 9¾″. 7*s.* 6*d.*

Forestry Commission. Census of woodlands 1947–49, woods of five acres and over: Welsh county details. London, H.M.S.O., 1953. viii, 90p. 12¾″. 4*s.* (Census Report, 3.)

General Register Office. External migration: a study of the available statistics 1815–1950; by N. H. Carrier ... and J. R. Jeffery ... London, H.M.S.O., 1953. 163p. 12¾″. 8*s.* 6*d.* (Studies on Medical and Population Subjects, 6.)

Ministry of Agriculture and Fisheries. Report of the Working Party on Quality Milk Production. London, H.M.S.O., 1953. iv, 35p. 9½″. 1*s.* 6*d.*

Ministry of Labour and National Service. Industrial relations handbook: an account of the organisation of employers and workpeople in Great Britain; collective bargaining and joint negotiating machinery; conciliation and arbitration; and statutory regulation of wages in certain industries. Rev. ed. London, H.M.S.O., 1953. v, 284p. 8¼″. 4*s.* 6*d.*

Monopolies and Restrictive Practices Commission. Report on the supply and export of matches and the supply of match-making machinery. London, H.M.S.O., 1953. v, 136p. 9¾″. 4*s.* 6*d.*

Royal Commission on Scottish Affairs. Vol. I. Memoranda submitted ... by the Scottish departments. 118p. 4*s.* Vol. II. Memoranda submitted ... by H.M. Treasury and the trade and industry departments. 153 pp. 5*s.* Vol. III. Memoranda submitted ... by the Great Britain departments other than H.M. Treasury and the trade and industry departments. 223p. 6*s.* Edinburgh, H.M.S.O., 1953. 3 vols. 9½″.

Scotland. General Registry Office. Census 1951: report on the fifteenth census of Scotland ... Vol. I. Part 6. County of Angus. Edinburgh, H.M.S.O., 1953. 46p. 13¼″. 11*s.* 6*d.*

Scottish Home Department. Digest of Scottish statistics. No. I April 1953. Edinburgh, H.M.S.O., 1953. iv, 44p. 11″. 4*s.*

Treasury. Government statistical services. London, H.M.S.O., 1953. 28p. 9½″. 1*s.* 3*d.*

Report of the Committee on Tax-paid Stocks. London, H.M.S.O., 1953. v, 58p. 9½″. 1*s.* 9*d.* Cmd. 8784.

Report of the Purchase Tax (Valuation) Committee ... May 1953. London, H.M.S.O., 1953. iv, 51p. 9½″. 1*s.* 9*d.* Cmd. 8830.

Australia. *Commonwealth Bureau of Census and Statistics.* Census of the Commonwealth of Australia. 30th June, 1947. Vol. I. Comprising parts I. to XVI. of the detailed tables ... Canberra, [1953]. viii, 927p. 12¾″. Part XXI.—Analysis of dwellings in local government areas. Victoria. Canberra, 1953. 1694–1749p. 13″.

Cyprus. *Statistics Section of the Secretariat.* Cyprus vital and migration statistics 1951–1952; by Lefkos P. Georghiades ... Nicosia, 1953. 3 p.l., 81 p. 12″.

Denmark. *Det Statistiske Departement.* Kapital-og betalingsbalancen over for undlandet 1951. København, 1953. 62p. 9¼″. 1.50 *kr.* (Statist. Medd. 4.149.5.)

Economic Commission for Europe. *Steel Committee.* European steel exports and steel demand in non-European countries. Geneva, 1953 (London, H.M.S.O.). iii, 242p. statistical annex, 14 p. maps. 11″. 9*s.*

Eire. *Central Statistics Office.* Census of population of Ireland 1946. Vol. VI. Industrial status. Dublin, Stationery Office, 1953. v, 103p. 9¾″. 4*s.*

Food and Agriculture Organization. European timber statistics 1913–1950. Geneva, 1953 (London H.M.S.O.). 1 p.l., iii, 30, [69]p. 10¾″. 12*s.* 6*d.*

Germany. *Bundesminister für den Marshall plan.* Wiederaufbau im Zeichen des Marshallplanes 1948–1952. Bonn, 1953. 223p. 11¾″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Statistisches Bundesamt. Betriebsverhältnisse im Gemüse-, Obst- und Gartenbau: Ergebnisse der Gartenbauerhebung vom 15. Oktober 1950. Stuttgart-Köln, W. Kohlhammer, 1953. 347p. 11¾″. (Statistik der Bundesrepublik Deutschland 26.)

Die Bevölkerung der Bundesrepublik Deutschland nach der Zählung vom 13.9.1950. Heft 3. Die Bevölkerung nach dem Wohnort am 1.9.1939. 1953. 28p. map. 11¾″. (S.B.D. 35.)

Die berufliche und soziale Gliederung der Bevölkerung der Bundesrepublik Deutschland nach der Zählung vom 13.9.1950. Teil I. Heft I. Die Bevölkerung nach der Erwerbstätigkeit. 1953. 311p. maps. 11¾″. (S.B.D.36.) ... Teil II. Heft 3. Die Erwerbspersonen nach Berufsordnungen und der nebenberuflichen Erwerbstätigkeit. 1953. 160p. 11¾″. (S.B.D. 37.)

Die Schulden von Bund, Ländern und Gemeinden am 31. März 1951. 1952. 39p. 11¾″. (S.B.D. 53.)

Das Bauhauptgewerbe im Juli 1952 (Ergebnisse der Totalerhebung). 1953. 64p. 11¾″. (S.B.D. 78.)

India. *Department of Economic Affairs.* The national sample survey: general report no. 1 on the first round October 1950—March 1951. [Calcutta], 1952. 4p. l, 106, 1v, [27]p. map. 9½″. Presented by Prof. Mahalanobis.

New Zealand. *Census and Statistics Department.* New Zealand: population census, 1951. Vol. I. Increase and location of population. Wellington, 1953. 112p. maps. 12¼″.

Peru. *Banco Central del Reserva de Perú.* Renta nacional del Perú (Peruvian national income) 1942–1951. Lima, 1952. 100p. 11″.

Rajasthan. *Bureau of Statistics.* A statistical outline of Rajasthan. Jaipur, 1953. 2p.l., iv, 73p. 9¾″. 1/8 *Rs.*

A statistical study of the general elections in Rajasthan 1952. Jaipur, [n.d.]. 2p. l., 105p. 9½″. 2 *Rs.*

Southern Rhodesia. *Central African Statistical Office.* The balance of payments of Southern Rhodesia 1946–1952. Salisbury, 1953. 2p. l, 37p. 12″.

Report on Northern Rhodesia family expenditure survey 1951. Salisbury, 1953. iii, 65p. 12″.

Vienna. *Magistrat der Bundeshauptstadt Wien.* Die Verwaltung der Bundeshauptstadt Wien vom 1. Jänner bis 31. Dezember 1951. Wien, 1953. 376p. 8¼″.

United Nations. *Department of Economic Affairs.* Economic survey of Asia and the Far East 1952. ...; prepared by the Research and Statistics Division, Economic Commission for Asia and the Far East. Bangkok, 1953 (London, H.M.S.O.). xv, 104 p. 11″. 7*s.* 6*d.*

The European steel industry and the wide-strip mill: a study of production and consumption trends in flat products; prepared by the Industry Division, Economic Commission for Europe. Geneva, 1953 (London, H.M.S.O.). viii, 100p. 11″. 7*s.* 6*d.*

United States of America. *Children's Bureau.* Juvenile delinquency: causes—prevention—treatment; an annotated bibliography compiled by the Federal Security Agency Library. Washington, 1953. 2p.l., 41p. 10½″.

National Bureau of Standards. Table of arctan *x*. Washington, Supt. of Documents, 1953. xiii, 170p. 10¾″. $1.75. (Applied Mathematics Series, 26.) A reissue of Mathematical Table 16.

World Health Organization. Amplification of medical certification of cause of death: inquiries to certifiers concerning incomplete or vague statements. Geneva, 1953. 44p. 9½″. (Bulletin, Supplement 5.)

Manual of the international statistical classification of diseases, injuries, and causes of death. Addendum 1. Supplementary interpretations and instructions for coding causes of death. Geneva, 1953. 55p. 9½″. (Bulletin, Supplement 6.)

II.—AUTHORS AND MISCELLANEOUS.

Adler (Max K.). Independent candidates in 1945, 1950, and 1951. *Pol. Stud.* (1953), **1**, 80–83. 9¼″. Presented by the author.

Allais (M.). La gestion des houillères nationalisées et la théorie économique. [Paris], Imprimerie Nationale, [1953]. 126p. incl. diagrs. 10½″.

Allbaugh (Leland G.). Crete: a case study of an underdeveloped area; by Leland G. Allbaugh ... with the editorial assistance of George Soule. Princeton, N.J., Princeton University Press, 1953 (London, Geoffrey Cumberlege). xx, 572p. photos., fold. maps. 9¼″. 48*s.* A survey undertaken by the Rockefeller Foundation, 1948.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Armitage (P.) *& others.* The protective action of antihistamines in the anaphylactic microshock of the guinea-pig; by P. Armitage, H. Herxheimer, and L. Rosa. *Brit. J. Pharmacol.* (1952), **7**, 625–636. 9¾″. Presented by the authors.

Berent (Jerzy). Relationship between family sizes of two successive generations. *Milbank Mem. Fd. Quart. Bull.* (1953), **31**, 40–50. 9″.

Berkson (Joseph). Tables for assisting the fitting of the logistic function. Rochester, Minn., Mayo Clinic, 1953. 6p. + table of logits, 1p. table of antilogits, 1p. logistic weights, 2p. 11″. Presented by the author.

Why I prefer logits to probits. *Biometrics* (1951), **7**, 327–339. 9¼″. Presented by the author.

Bliss (C. I.). The statistics of bioassay with special reference to the vitamins ... Reprinted, with additions, from Vitamin methods vol. II. New York, Academic Press, 1952. iii, 445–628p. 9″. $3.50.

Borneman (Roy) & Hughes (Percy F.). The profits tax. 2nd ed. London, Taxation Publishing Co., 1953. xxix, 332p. 8½″. 21*s.*

Bose (R. C.). On some new series of balanced incomplete block designs. *Bull. Calcutta Math. Soc.* (1942), **34**, 17–31. 9½″. Presented by Mr. J. Maclean.

Brooks (C. E. P.) & Carruthers (N.). Handbook of statistical methods in meteorology. London, H.M.S.O., 1953. viii, 412p. 9½″. 25*s.* (M.O. 538.) Bibliog. p. 396–402.

Cambridge, University of. Department of Applied Economics. An exercise in errors; [by] A. D. Roy. *J. R. Statist. Soc.* A (1952), **115**, 507–520. 9¾″. (Reprint Series, 68.)

Non-linear estimates of the Engel curves ; [by] S. J. Prais. *Rev. Econ. Stud.* (1953), **20**, 87–104. 9¾″. (Reprint Series, 69.)

The relationship between input-output analysis and national accounting ; [by] Richard Stone and J. E. G. Utting. 195–229p. 9½″. (Reprint Series, 70.) Reprinted from Input-output relations: proceedings of a Conference on Inter-industrial Relations held at Driebergen, Holland (Netherlands Economic Institute, 1953).

Forecasting from econometric equations: a further note on derationing; [by] Richard Stone and S. J. Prais. *Econ. J.* (1953), **63**, 189–195. 9½″. (Reprint Series, 71.)

Charnes (A.) *& others.* An introduction to linear programming. Part I. An economic introduction to linear programming; by W. W. Cooper and A. Henderson. Part II. Lectures on the mathematical theory of linear programming; by A. Charnes. New York, Wiley, 1953 (London, Chapman & Hall). ix, 74p. 11″. 20*s.*

The Child on the road: a report based on a study of the experience of 1951; presented to the National Federation of Women's Institutes May 1953. London, Economic Research Council for the Children's Safety Crusade Trust, 1953. 72p. 9½″. 4*s.*

Christensen (P. Agerholm) & Finney (D. J.). Standardization of cobra (*Naja flava*) venom using the graded response method. *J. Immunol.* (1953), **70**, 7–20. 10″. Presented by the authors.

Clark (Charles E.). An introduction to statistics. New York, Wiley, 1953 (London, Chapman & Hall). x, 266p. 9″. 34*s.*

Cochran (William G.). Sampling techniques. New York, Wiley, 1953 (London, Chapman & Hall). xiv, 330p. 9″. 52*s.*

Cohen (Morris R.) & Nagel (Ernest). An introduction to logic and scientific method ... Complete ed. London, Routledge, 1951. xii, 467p. 8½″. 30*s.*

Crew (F. A. E.). The army medical services ... Administration. Vol. I. London, H.M.S.O., 1953. xxii, 530p. photos. 9½″. 50*s.* (History of the Second World War, U.K. Medical Series.)

Crum (William Leonard). The age structure of the corporate system. Berkeley, University of California Press, 1953. xii, 181p. 9¼″. $3.50. (Publications of the Bureau of Business and Economic Research.)

Doob (J. L.). Stochastic processes. New York, Wiley, 1953 (London, Chapman & Hall). vii, 654p. 9″. 80*s.*

Finney (D. J.). An introduction to statistical science in agriculture. Edinburgh & London, Oliver & Boyd, 1953. 179p. 9½″. 25*s.*

Florence (P. Sargant). The logic of British and American industry: a realistic analysis of economic structure and government. London, Routledge, 1953. xiv, 368p. 8½″. 28*s.*

Fortunati (Paolo). Da minoranza reale a maggioranza pseudo-legale; da un sistema elettorale a trentuno sistemi elettorali; dalla competizione politica alla crociata sanfedista. Discorsi pronunciati al Senato della Repubblica nelle sedute dell'11 e 18 marzo 1953. Roma, Tipografia del Senato, 1953. 56p. 11½″. Presented by the author.

Glass (D. V.), *editor.* Introduction to Malthus. London, Watts, 1953. x, 205p. 7¾″. 10*s.* 6*d.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Gokhale Institute of Politics and Economics. Poona: a socio-economic survey. Part II; by D. R. Gadgil, assisted by the staff of the Institute. Poona, 1952. xi, 324p. maps. 9¾″. 30*s*. (Publication 25.)

Hamilton (M.) *& others.* The treatment of intermittent claudication with vitamin E. *Lancet* (1953), Feb. 21, 367. 12p. 8½″. By M. Hamilton, G. M. Wilson, P. Armitage and J. T. Boyd. Presented by the authors.

Hammersley (J. M.). On a conjecture of Nelder. *Compos. Math.* (1952), **10**, 241–244. 9½″. Tables of complete elliptic integrals. *J. Res. Nat. Bur. Stand.* (1953), **50**, 43. 10¼″. Presented by the author.

Holmstrom (J. Edwin). Facts, files and action in business and public affairs. Part two. Filing, indexing and circulation. London, Chapman & Hall, 1953. xvi, 280p. incl. photos., diagrs. 8½″. 32*s*.

Hurstfield (J.). The control of raw materials. London, H.M.S.O. and Longmans, Green, 1953. xv, 530p. 9½″. 35*s*. (History of the Second World War, U.K. Civil Series, War Production Series.)

Ingram (G. I. C.) & Armitage (P.). The effect of penicillin and of streptomycin on blood coagulation in normal subjects; by G. I. C. Ingram ... with experimental design and analyses by P. Armitage ... *J. Pharm., Lond.* (1952), **4**, 1047–1061. 9″. Presented by the authors.

Ingram (G. I. C.) *& others.* Laboratory tests for incipient thrombosis; by G. I. C. Ingram, Rosemary Biggs, and P. Armitage. *J. Clin. Path.* (1953), **6**, 46–51. 9¾″. Presented by the authors.

Kendall (Maurice G.). The advanced theory of statistics ... Vol. I. 5th ed. London, Griffin, 1952. xii, 457p. 10½″. 52*s*.

Kuznets (Simon) & Jenks (Elizabeth). Shares of upper income groups in income and savings. New York, National Bureau of Economic Research, 1953. xli, 725p. 9″. (Publication 55.)

Lee (Y. W.). Application of statistical methods to communication problems. Cambridge, Mass., Massachusetts Institute of Technology, Research Laboratory of Electronics, 1950. 2p.l., 39p. 11″. (Technical Report, 181.)

Lehmann (E. L.). The power of rank tests. *Ann. Math. Statist.* (1953), **24**, 23–43. 10″. Presented by the author.

Leigh-Dugmore (C. H.). Carbon black particle size. Cambridge, Heffer, 1953. *I.R.I. Trans.*, **29**, 92–99. 8½″. Presented by the author.

Lengyel (S. J.). International insurance transactions: insurance in the balances-of-payments. University of Melbourne, Faculty of Economics and Commerce, 1953 (London, Wadley & Ginn). 6p.l., 139p. 9½″. 55*s*.

Leontief (Wassily) *& others.* Studies in the structure of the American economy: theoretical and empirical explorations in input-output analysis. New York, O.U.P., 1953 (London, Geoffrey Cumberlege). x, 561p. 4 fold. tables. 9¼″. 88*s*.

Lévy (Paul). Random functions: general theory with special reference to Laplacian random functions. Berkeley, University of California Press, 1953. 331–390p. 10¼″. (University of California Publications in Statistics, vol. 1, no. 12.) Presented by the author.

Lindquist (E. F.). Design and analysis of experiments in psychology and education. Boston, Mass. [etc.], Houghton Mifflin, 1953. xix, 393p. 9¼″. $6.50.

Lorie (James H.) & Roberts (Harry V.). Basic methods of marketing research. New York & London, McGraw-Hill, 1951. xii, 453p. 9″. 51*s*.

McGaw (Howard F.). Marginal punched cards in college and research libraries. Washington, The Scarecrow Press, 1952 (London, Bailey & Swinfen). 218p. 8½″. 40*s*. 6*d*.

Madge (John H.). The tools of social science. London, Longmans, Green, 1953. x, 308p. 8½″. 25*s*.

Martin (Anne) & Lewis (J. Parry). Welsh economic statistics: a handbook of sources ... with a preface by Professor Brinley Thomas. Cardiff, University College of South Wales and Monmouthshire, Department of Economics and Social Science, 1953. ivp., 2p.l., 96p. 12¾″. 8*s*. 6*d*. Presented by Professor Brinley Thomas.

Martin (W. J.). The trend of infant mortality in the county boroughs of England and Wales. *Mon. Bull. Minist. Hlth. Lab. Serv.* (1953), March, 56–66. 9¾″.

Mashayekhi (Mohammad B.) *& others.* Some demographic aspects of a rural area in Iran; [by] Mohammad B. Mashayekhi, Pauline A. Mead and Guy S. Hayes. *Milbank Mem. Fd. Quart. Bull.* (1953), **31**, 149–165. 9″.

Mehta (S. D.). The Indian cotton textile industry: an economic analysis. Bombay, Textile Association, 1953. xxii, 232p. 9¾″. 12*Rs*.

Milne (William Edmund). Numerical solution of differential equations. New York, Wiley, 1953 (London, Chapman & Hall). xi, 275p. 9″. 52*s*. (Applied Mathematics Series.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

National Bureau of Economic Research. Business cycle research and the needs of our times: [by] Arthur F. Burns ... New York, 1953. 3p.l., 86p. 9″. (33rd Annual Report.)

Nellner (Werner). Die Wanderungen im Bundesgebiet 1951. Bad Godesberg, Institut für Raumforschung Bonn, 1953. 4p.l., 45p. tables [29]p. English summary [2]p. 3 col. maps, 5 diagrs. 11½″. 4*DM*. (Mitteilungen, 18.)

Neyman (Jerzy) & *others*. On the spatial distribution of galaxies: a specific model; [by] J. Neyman, E. L. Scott and C. D. Shane. *Astrophys. J.* (1953), **117**, 92–133. 9½″. Presented by the authors.

North Carolina, Consolidated University of. Institute of Statistics. Research notes: some useful results in Jacobians; by S. N. Roy. *Calcutta Statist. Ass. Bull.* (1952), **4**, 117–122. (Reprint Series, 28.)

A note on Nair's condition for partially balanced incomplete block designs with $k>r$; by R. C. Bose. *Calcutta Statist. Ass. Bull.* (1952), **4**, 123–126. 9¾″. (Reprint Series, 29.)

Nurske (Ragnar). Problems of capital formation in underdeveloped countries. Oxford, Blackwell, 1953. 4p.l., 163p. 8½″. 15*s*.

Österreichisches Institut für Wirtschaftsforschung. Österreichs Wirtschaft im Übergang von der Stabilisierung zur Expansion; von Dr. Franz Nemschak ... Wien, 1953. 26p. 9½″. (Vorträge and Ausfätze, 6.)

Rosser (J. Barkley). Logic for mathematicians. New York & London, McGraw-Hill, 1953. xiv, 530p. 9″. 85*s*.

Royal Society of New Zealand. Report of the seventh Science Congress, Christchurch, May 15–21 (inclusive), 1951 ... honorary editor Maurice A. Black. Christchurch, 1952. 2p.l., vi, 256p. 9½″.

Rushton (S.). On sequential tests of the equality of variances of two normal populations with known means. *Sankhyā* (1952), **12**, 63–78. 11¼″. Presented by the author.

Sampford (M. R.). The estimation of response-time distributions. II. Multi-stimulus distributions. *Biometrics* (1952), **8**, 307–369. 9¼″.

Some inequalities on Mill's ratio and related functions. *Ann. Math. Statist.* (1953), **24**, 130–132. 10″. Presented by the author.

Sandelius (Martin). Inverse sampling applied to bacterial plate counts. II. Cases when technical errors cannot be neglected. *K. Lantbrukshögskolans Ann.* (1953), **19**, 197–204. 8½″.

Some unbiassed estimates for a type of two-phase sampling. *K. Lantbrukshögskolans Ann.* (1953), **19**, 113–126. 8½″. Presented by the author.

Skellam (J. G.). Studies in statistical ecology. I. Spatial pattern. *Biometrika* (1952), **39**, 346–362. 10¾″.

Staples (Ronald), editor. "Taxation" key to income tax and surtax ... 36th ed. London, Taxation Publishing Co., 1953. 222p. 8½″. 7*s*. 6*d*.

"Taxation" manual; compiled by barristers and experts under the direction of Ronald Staples ... London, Taxation Publishing Co., 1953. xx, 431p. 8½″. 20*s*.

Stoll (Robert R.). Linear algebra and matrix theory. New York & London, McGraw-Hill, 1952. xv, 272p. 9″. 48*s*.

Swain (Marianne De Graff) & Kiser (Clyde V.). Social and psychological factors affecting fertility. XVIII. The interrelation of fertility, fertility planning, and ego-centred interest in children. *Milbank Mem. Fd. Quart. Bull.* (1953), **31**, 51–84. 9″.

Westoff (Charles F.). The changing focus of differential fertility research: the social mobility hypothesis. *Milbank Mem. Fd. Quart. Bull.* (1953), **31**, 24–38. 9″.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REGISTRATION OF THE UNITED KINGDOM AND EIRE

No. I.—ENGLAND AND WALES

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1948–1952 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age; rate per* 1,000 *related Live Births. Stillbirths per* 1,000 *births.)*

Years	1948		1949		1950		1951		1952†	
Estimated Mid-year Popln. in thousands‡	43,502		43,785		43,830		43,800§		43,940	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	776,971	*17·9*	731,172	*16·7*	691,760	*15·8*	679,689	*15·5*	673,559	*15·3*
Stillbirths	18,469	*23*	16,977	*23*	16,055	*23*	16,019	*23*	15,578	*23*
Deaths[1]	469,898	*10·8*	510,736	*11·7*	510,301	*11·6*	549,380	*12·5*	497,290	*11·3*
Marriages	396,891	*9·1*	375,041	*8·6*	358,490	*8·2*	360,624	*8·2*	348,546	*8·0*
Infant Mortality ..	26,766	*34*	23,882	*32*	20,817	*30*	20,223	*30*	18,425	*28*
Effective reproductive rate[2]	*1·070*		*1·023*		*0·986*		*0·969*		*0·98*	
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	202,047	*18·7*	186,611	*17·3*	180,130	*16·7*	176,047	*16·3*	173,503	*15·9*
Apr.–June	203,593	*18·8*	192,038	*17·6*	181,343	*16·6*	181,614	*16·6*	174,089	*15·9*
July–Sept.	191,858	*17·5*	183,221	*16·6*	170,087	*15·4*	168,033	*15·2*	167,938	*15·2*
Oct.–Dec.	179,473	*16·4*	169,302	*15·3*	160,200	*14·5*	153,995	*13·9*	158,029	*14·3*
	Stillbirths									
Jan.–Mar.	5,045	*24*	4,446	*23*	4,238	*23*	4,259	*24*	4,146	*23*
Apr.–June	4,746	*23*	4,496	*23*	4,172	*23*	4,196	*23*	3,995	*22*
July–Sept.	4,447	*23*	4,118	*22*	3,919	*23*	3,752	*22*	3,696	*22*
Oct.–Dec.	4,231	*23*	3,917	*23*	3,726	*23*	3,812	*24*	3,741	*23*
	Deaths[1] (excluding Stillbirths)									
Jan.–Mar.	132,628	*12·3*	161,265	*14·9*	151,284	*14·0*	205,878	*19·1*	146,631	*13·4*
Apr.–June	110,257	*10·2*	119,972	*11·0*	120,791	*11·1*	121,683	*11·1*	115,406	*10·6*
July–Sept.	101,548	*9·3*	101,190	*9·2*	102,867	*9·3*	100,057	*9·1*	98,666	*8·9*
Oct.–Dec.	125,465	*11·5*	128,309	*11·6*	135,359	*12·3*	121,762	*11·0*	136,587	*12·4*
	Marriages									
Jan.–Mar.	95,443	*8·8*	81,774	*7·6*	86,900	*8·0*	109,567	*10·2*	106,560	*9·8*
Apr.–June	92,822	*8·6*	95,565	*8·8*	80,726	*7·4*	66,382	*6·1*	69,236	*6·4*
July–Sept.	123,157	*11·2*	114,405	*10·4*	114,828	*10·4*	111,312	*10·1*	103,079	*9·4*
Oct.–Dec.	85,469	*7·8*	83,297	*7·6*	76,036	*6·9*	73,363	*6·7*	69,671	*6·3*
	Infant Mortality									
Jan.–Mar.	8,387	*41*	7,532	*40*	6,575	*39*	6,572	*38*	5,588	*33*
Apr.–June	6,357	*31*	5,758	*30*	5,034	*29*	5,066	*29*	4,290	*25*
July–Sept.	5,514	*28*	4,915	*27*	4,176	*24*	4,003	*23*	3,865	*23*
Oct.–Dec.	6,508	*35*	5,677	*32*	5,032	*28*	4,583	*29*	4,682	*29*

* All rates are based on the estimated population as at the middle of the corresponding year.
† Provisional figures.
‡ For 1948–1949, total populations, i.e., including members of Armed Forces stationed at home and abroad. For 1950–1952, home populations, i.e., including members of Armed Forces stationed within England and Wales.
§ Examination in the light of the new Census data indicated that the estimates of preceding years had become inflated and that but for this a population increase of some 46,000 would have been recorded for the year 1950/51 instead of the decline of 30,000 shown above.
[1] Including deaths of non-civilians registered in England and Wales.
[2] Based not upon current, but upon estimated future mortality.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

No. II.—SCOTLAND

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1948–1952, *and in the Quarters of those years. Numbers, Annual and Quarterly Rates*, per* 1,000 *persons living. (Deaths under* 1 *year of age, rate per* 1,000 *Live Births; Stillbirths per* 1,000 *Births.)*

Years	1948		1949		1950		1951†		1952†	
Estimated mid-year Popln. in thousands‡	5,169		5,175		5,175		5,114		5,114	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	100,344	*19·4*	95,674	*18·5*	92,530	*17·9*	90,639	*17·7*	90,422	*17·7*
Stillbirths	2,966	*29*	2,666	*27*	2,557	*27*	2,479	*27*	2,430	*26*
Deaths	60,979	*11·8*	63,488	*12·3*	63,996	*12·4*	65,778	*12·9*	61,511	*12·0*
Marriages	43,718	*8·5*	41,708	*8·1*	40,459	*7·8*	41,361	*8·1*	41,158	*8·0*
Infant Mortality ..	4,486	*45*	3,961	*41*	3,569	*39*	3,391	*37*	3,181	*35*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	25,324	*19·8*	24,230	*19·0*	23,542	*18·5*	23,625	*18·8*	22,892	*18·0*
Apr.–June	26,561	*20·7*	25,424	*19·7*	24,646	*19·1*	24,310	*19·1*	23,531	*18·5*
July–Sept.	24,389	*18·7*	23,324	*17·9*	22,498	*17·3*	21,932	*17·0*	22,161	*17·3*
Oct.–Dec.	24,070	*18·5*	22,696	*17·4*	21,844	*16·8*	20,772	*16·1*	21,838	*17·0*
	Stillbirths									
Jan.–Mar.	760	*29*	707	*28*	673	*28*	657	*27*	676	*29*
Apr.–June	775	*28*	710	*27*	659	*26*	658	*26*	598	*25*
July–Sept.	711	*28*	642	*27*	627	*27*	575	*26*	541	*24*
Oct.-Dec.	720	*29*	607	*26*	598	*27*	589	*28*	615	*27*
	Deaths (excluding Stillbirths)									
Jan.–Mar.	16,825	*13·1*	19,222	*15·1*	18,647	*14·7*	22,428	*17·8*	18,394	*14·5*
Apr.–June	14,698	*11·4*	15,274	*11·8*	14,986	*11·6*	15,442	*12·1*	14,270	*11·2*
July–Sept.	13,652	*10·5*	13,119	*10·1*	13,341	*10·2*	13,104	*10·2*	12,813	*10·0*
Oct.–Dec.	15,804	*12·2*	15,873	*12·2*	17,022	*13·1*	14,804	*11·5*	16,034	*12·5*
	Marriages									
Jan.–Mar.	9,959	*7·8*	10,638	*8·4*	11,111	*8·7*	11,560	*9·2*	12,424	*9·8*
Apr.–June	10,490	*8·2*	9,209	*7·1*	8,680	*6·7*	8,958	*7·0*	8,156	*6·4*
July–Sept.	13,509	*10·4*	12,786	*9·8*	11,847	*9·1*	12,048	*9·3*	11,893	*9·3*
Oct.–Dec.	9,760	*7·5*	9,075	*7·0*	8,821	*6·8*	8,795	*6·8*	8,685	*6·8*
	Infant Mortality									
Jan.–Mar.	1,303	*51*	1,225	*51*	1,080	*46*	1,088	*46*	872	*38*
Apr.–June	1,144	*43*	913	*36*	841	*34*	850	*35*	801	*34*
July–Sept.	972	*40*	823	*35*	737	*33*	698	*32*	663	*30*
Oct.–Dec.	1,067	*44*	1,000	*44*	911	*42*	755	*36*	845	*39*

* Death rates for 1948–49 are based on all deaths registered in Scotland, related to the total population.
,, ,, 1950–52 ,, ,, ,, ,, ,, ,, ,, home ,,
† Provisional figures.
‡ 1948–49 = Estimated mid-year total population (including persons serving outside Scotland with the Mercantile Marine and, under the National Service Act, H.M. Forces).
1950–52 = Estimated mid-year home population (including members of Mercantile Marine at home and abroad).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

No. III.—NORTHERN IRELAND

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1948–1952 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age; rate per* 1,000 *Live Births.)*

Years	1948		1949		1950		1951		1952[2]	
Estimated Mid-Year Popln. in thousands*	1,351		1,360		1,369		1,373		1,375	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	29,532	*21·9*	29,106	*21·4*	28,794	*21·0*	28,477	*20·7*	28,760	*20·9*
Stillbirths[1]					Not registered					
Deaths	15,125	*11·2*	15,652	*11·5*	15,839	*11·6*	17,628	*12·8*	14,812	*10·8*
Marriages	9,360	*6·9*	9,216	*6·8*	9,084	*6·6*	9,414	*6·9*	9,300	*6·8*
Infant Mortality	1,347	*46*	1,317	*45*	1,166	*40*	1,173	*41*	1,117	*39*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	7,412	*22·1*	7,379	*21·8*	7,275	*21·3*	7,254	*21·2*	7,095	*20·8*
Apr.–June	8,030	*23·9*	7,764	*22·9*	7,725	*22·5*	7,769	*22·6*	7,589	*22·2*
July–Sept.	7,262	*21·5*	7,193	*21·2*	7,090	*20·7*	7,089	*20·5*	7,215	*20·9*
Oct.–Dec.	6,828	*20·2*	6,770	*19·9*	6,704	*19·5*	6,365	*18·4*	6,861	*19·9*
	Deaths‡ (excluding Stillbirths)									
Jan.–Mar.	4,313	*12·8*	4,758	*14·0*	4,551	*13·3*	6,971	*20·4*	4,450	*13·0*
Apr.–June	3,817	*11·4*	3,812	*11·2*	3,925	*11·4*	3,951	*11·5*	3,671	*10·7*
July–Sept.	3,323	*9·9*	3,228	*9·5*	3,222	*9·4*	3,211	*9·3*	3,093	*9·0*
Oct.–Dec.	3,672	*10·9*	3,854	*11·3*	4,141	*12·1*	3,495	*10·1*	3,598	*10·4*
	Marriages									
Jan.–Mar.	2,150	*6·4*	1,975	*5·8*	2,055	*6·0*	2,210	*6·5*	2,272	*6·7*
Apr.–June	2,158	*6·4*	2,287	*6·7*	2,081	*6·1*	1,958	*5·7*	2,099	*6·1*
July–Sept.	2,972	*8·8*	2,862	*8·4*	3,066	*9·0*	3,174	*9·0*	2,988	*8·7*
Oct.–Dec.	2,080	*6·2*	2,092	*6·1*	1,882	*5·5*	2,072	*5·9*	1,941	*5·6*
	Infant Mortality									
Jan.–Mar.	395	*53*	402	*55*	323	*44*	371	*51*	317	*45*
Apr.–June	352	*44*	297	*38*	284	*37*	292	*38*	288	*38*
July–Sept.	302	*41*	309	*43*	253	*36*	255	*36*	232	*32*
Oct.–Dec.	298	*44*	309	*46*	305	*45*	255	*40*	280	*41*

* For 1948–50 rates are based on Civilian Population only; for 1951–52 they are based on "Home" Population (Civilians and members of H.M. Forces stationed in Northern Ireland).

‡ For 1948–50 civilian deaths only; for 1951–52, total deaths registered.

[1] Stillbirths are not registered in Northern Ireland. The birth of one living child and one stillborn, or one living child and two stillborn, is counted as one birth.

[2] By courtesy of the Registrar-General for Northern Ireland.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

No. IV.—EIRE

BIRTHS, DEATHS *and* MARRIAGES *registered in the Calendar years* 1948–1952 *and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per* 1,000 *persons living. (Deaths under* 1 *year of age, rate per* 1,000 *Live Births.)*

Years	1948		1949		1950[1]		1951†		1952†	
Estimated Mid-year Popln. in thousands	2,985		2,981		2,969		2,959		2,948	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	65,930	*22·0*	64,153	*21·5*	63,565	*21·4*	62,587	*21·2*	64,226	*21·8*
Stillbirths‡					Not registered					
Deaths	36,357	*12·1*	38,062	*12·7*	37,741	*12·7*	42,412	*14·3*	35,155	*11·9*
Marriages	16,115	*5·4*	16,009	*5·4*	16,018	*5·4*	15,860	*5·4*	15,769	*5·3*
Infant Mortality	3,313	*50*	3,415	*53*	2,922	*46*	2,840	*45*	2,646	*41*
Quarters	Live Births in the Quarters of each Calendar Year									
Jan.–Mar.	16,310	*21·9*	16,388	*21·9*	15,843	*21·3*	15,669	*20·9*	16,090	*21·8*
Apr.–June	18,143	*24·3*	16,774	*22·4*	17,172	*23·1*	16,908	*22·5*	17,524	*23·8*
July–Sept.	16,385	*22·0*	16,519	*22·1*	15,960	*21·5*	16,204	*21·9*	15,845	*21·5*
Oct.–Dec.	15,092	*20·2*	14,472	*19·4*	14,590	*19·7*	13,806	*18·7*	14,767	*20·0*
	Deaths (excluding Stillbirths)									
Jan.–Mar.	10,612	*14·2*	11,010	*14·7*	11,172	*15·1*	16,600	*22·1*	10,658	*14·4*
Apr.–June	9,333	*12·5*	9,920	*13·3*	9,687	*13·1*	10,220	*13·6*	8,731	*11·8*
July–Sept.	7,865	*10·5*	8,082	*10·8*	7,690	*10·4*	7,653	*10·3*	7,267	*9·9*
Oct.–Dec.	8,547	*11·5*	9,050	*12·1*	9,192	*12·4*	7,939	*10·7*	8,499	*11·5*
	Marriages									
Jan.–Mar.	3,568	*4·8*	3,622	*4·8*	3,429	*4·6*	3,327	*4·4*	3,441	*4·7*
Apr.–June	4,000	*5·4*	3,620	*4·8*	3,813	*5·1*	3,854	*5·2*	3,692	*5·0*
July–Sept.	5,011	*6·7*	5,186	*6·9*	5,410	*7·3*	5,482	*7·4*	5,207	*7·1*
Oct.–Dec.	3,536	*4·7*	3,581	*4·8*	3,366	*4·5*	3,197	*4·3*	3,429	*4·7*
	Infant Mortality									
Jan.–Mar.	1,059	*65*	928	*57*	962	*61*	916	*58*	877	*55*
Apr.–June	857	*47*	856	*51*	778	*45*	773	*46*	611	*35*
July–Sept.	649	*40*	749	*45*	584	*37*	589	*36*	567	*36*
Oct.–Dec.	748	*50*	882	*61*	598	*41*	562	*41*	591	*40*

* Rates are based on the total estimated population as at the middle of the corresponding year.
† Provisional figures.
‡ Stillbirths are not registered in Eire. The births of one living child and one stillborn, or of one living child and two stillborn, are counted as one birth.
[1] Final figures by courtesy of the Registrar-General for Eire.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART IV, 1953

An Experimental Study of Quota Sampling

By C. A. Moser and A. Stuart

Division of Research Techniques, London School of Economics

[Read before the Royal Statistical Society, May 27th, 1953, Mr. E. C. Fieller, Vice-President, in the Chair]

Contents

PAGE

I. *General Description*

1.1. Introduction 349
1.2. Quota and random sampling 350
1.3. Stages of research 351
1.4. The purpose of the experiment 352
1.5. Design and scale of the experiment 353
1.6. Location 354
1.7. Controls and quotas 355
1.8. Random samples 356
1.9. Questionnaire 356
1.10. Interview Record Sheets 357
1.11. Fieldwork and organization 357

II. *Response Rates and Completion of Quotas*

2.1. Response rates 357
2.2. Independent and interrelated quota schemes 359
2.3. Age-spread within quota cells 360

III. *The Questionnaire Results*

3.1. Comparison of random and quota sample results 362
3.2. The variability of quota samples 377
3.3. Differences between towns, organizations, control levels and assignment schemes 379
3.4. The sensitivity of the experiment 383

IV. *Conclusions* 385

I. *General Description*

1.1. *Introduction*

This paper describes research into quota sampling carried out within the Division of Research Techniques of the London School of Economics. The Division, which is financed by the Nuffield Foundation, is charged with the duty of investigating those techniques of research which are of interest to the various departments of the School and one of its principal tasks is the investigation of methods of sampling human populations.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

From the beginning, this task has been carried out with the assistance of the Government Social Survey and some of the principal market and opinion research bodies. This liaison ensures that our experiments are of operational interest and not divorced from every-day practice. It seems clear that, in this particular field, research is very fruitfully carried out in this co-operative manner, in which the academic approach and professional experience are complementary.

Throughout our research on quota sampling, objectives and detailed plans have been discussed and agreed by the Survey Research Committee, which consists of members of the Division and representatives of the participating organisations. Our sincere thanks are due to Mr. B. Emmett (B.B.C. Audience Research), Dr. H. Durant and Mr.W. Gregory (British Institute of Public Opinion), Mr. T. Cauter, Mr. F. Edwards and Mr. P. Parkinson (British Market Research Bureau), Mr. L. Moss (Government Social Survey), Mr. H. Henry (Market Information Services) and Mr. D. H. Pickard (Research Services) for their help throughout the various stages of this research and to their respective organizations for their efficient and unsparing co-operation. We should also like to express our thanks for the help given by the Director of the Division, Professor M. G. Kendall, and by our colleagues, Mr. H. S. Booker, Mr. S. T. David and, in particular, Mr. J. Durbin. Much of the hardest, and certainly most tedious work, was done by the staff of the Division, Mr. R. Cole (Research Assistant), Miss Baines (Secretary) and Miss Graham, Mrs. Howard and Miss McWilliams (Computors).

We should point out that the presentation of the results and the conclusions drawn from them in this paper are entirely the responsibility of the two authors and do not commit the other persons mentioned above.

1.2. *Quota and Random Sampling*

Quota sampling has, for a decade at least, been a subject of controversy both here and in the United States. On the whole, market and opinion researchers have favoured it, while academic statisticians have spared it no criticism, but neither opponents nor proponents have made serious attempts to back their claims by experimental evidence.

A previous paper arising out of the present research (1) has discussed the nature of quota sampling, its pros and cons and the problems which it creates.

Methods of sampling human populations may be conveniently divided into two groups: random and non-random methods. The commonest types of the former are systematic list sampling (quasi-random sampling) in the U.K. and area sampling in the United States, while by far the commonest type in the second group is quota sampling. There are many minor differences between quota and random sampling, but the essential one is that in random sampling the selection of the sampling units is carried out by some impersonal, strictly determined method, whereas, in quota sampling, once the general "breakdown" of the sample (e.g. numbers in the different sex, age and social class groups) is decided and each interviewer is given his assignment, the choice of the sample units to fit into this framework is left to the interviewers. It is this human element in respondent selection which is the crucial and most criticized aspect of quota sampling.

The issue of quota versus random sampling does not, of course, admit of a clear-cut answer in the sense that either method could be shown to be preferable in all cases. On many types of survey one would not think of using quota methods; on some, random sampling may be impracticable. Between these two situations, there is an area of survey work in which the two methods are regarded as genuine alternatives. This is the reason why, in spite of the theoretical argument against quota sampling, we regarded research into it as worth while. Often, in market and opinion research, the cheap but theoretically less sound quota technique is weighed against the more securely based but expensive random method. Practitioners will admit that quota sampling is perhaps more an art than a science and that it may not be as reliable as random sampling. However, the aim in surveys is generally to get maximum accuracy at a given cost and organizations have found that, in many cases, quota sampling seems to achieve this aim. This is the reason for our research. We wish to stress, however, that the comparison between random and quota sampling was not our only objective. We were equally interested to find out how quota sampling operates, how different types of quota sampling compare in their results, how much variability there is between quota interviewers, and so on.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

1.3. *Stages of Research*

Four types of approach were open to us and we have tried to follow each of them:

(i) *Preliminary study*

The obvious first step was to find out all we could about the organization and operation of quota sampling in this country. We wanted to know on what basis the quotas are set and how they are assigned to interviewers, what constraints with regard to quota filling are imposed and what instructions are given to interviewers, how the fieldwork is arranged and what checks are applied to test its efficiency and honesty. On these points, and many others, four organizations which practise quota sampling gave us the required information and a report has been published (1).

(ii) *Analysis of data from past surveys*

Our next step was to see whether any comparisons between random and quota sampling could be made from past surveys, either within or between organizations. Great care must be taken that such surveys refer to comparable populations, dates, questions, definitions and so forth, and a thorough search through the available material convinced us that there were no cases in which the bases of the results were strictly comparable, and that we must regretfully abandon this approach.

However, we were able to make comparisons from past surveys in one respect. The B.B.C., B.I.P.O. and R.S. provided us with the addresses of respondents interviewed on quota surveys in Bristol during a given period and we obtained similar data for random surveys from R.S. and the Government Social Survey. We tested the difference between the geographical spreads of the samples and population density figures by chi-squared. Though, for various reasons, the results of this analysis had to be treated with caution, they did suggest very marked bunching of the quota samples. While this does not necessarily matter in many surveys, we thought it worth while to incorporate a geographical control in part of the experiment described below, in order to see whether the spread of interviewing over an area was related to the accuracy of the quota sample results.

(iii) *Collection of demographic data*

Thirdly, we decided to compare the composition of routine quota and random surveys by various factual criteria. A number of questions (dealing with household composition, number of rooms, education, income, occupation and so forth) which are included in most Government Social Survey enquiries, were specially asked in a routine national quota survey of 8,000 interviews by B.M.R.B. and compared with a Government Social Survey enquiry of the same period (of 3,800 interviews). Social Survey definitions were used throughout. Our aim was merely to compare the composition of two national quota and random surveys. Whether any differences which were found mattered and how they were caused, were questions for later stages of the research. The date of both surveys was summer, 1951, the area covered, Great Britain.

Lack of space prevents us from giving all the comparisons, and we shall only summarize the main conclusions:

On most of the questions, the results from the two samples were very close. The age and sex distributions were bound to be so as they are the basis of the quotas assigned to interviewers.

The household compositions of the two samples were remarkably close, not only as judged by average size of household but also by the distributions. The proportion of women who were housewives was identical in the two samples. No basic differences appeared between the samples on type of dwelling and number of rooms occupied. As far as these various criteria were concerned, there was no evidence that the large national quota sample was biased in overall proportions.

When it came to the two questions most closely related to social or economic status, the picture was different; the random and quota samples differed markedly. On income, the first noticeable feature was the difference in Refusal/Don't Know percentages on the two samples. On the quota one, this was 13·5 per cent., on the random 6·6 per cent. In the distribution for those who had given the required information, there were large differences between the samples, as shown in Table 1.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 1

Distribution by Income. Quota and Random Samples. (Percentages)

Income Range	*Men*		*Women*	
	Quota Sample	*Random Sample*	*Quota Sample*	*Random Sample*
Nil and up to £3	8·1	13·6	74·0	76·8
£3–£5	17·4	11·6	19·6	15·8
£5–£7 10*s.*	48·5	42·6	4·6	5·2
£7 10*s.*–£10	15·0	21·3	·9	1·6
Over £10	11·0	10·8	·8	·6
Total	100·0	99·9	99·9	100·0

Most interesting of all were the differences in the occupational-industrial composition of the two samples, which are seen in Table 2.

TABLE 2

Distribution by Occupation/Industry. Quota and Random Samples. (Percentages)

Industry	*Men*		*Women*	
	Quota Sample	*Random Sample*	*Quota Sample*	*Random Sample*
Manufacturing	6·5	24·9	4·3	7·2
Clerical	3·8	5·0	4·2	4·6
Distributive	15·7	5·9	9·0	3·0
Transport and Public Services	18·3	7·6	1·3	—
Professional and Managerial	18·1	20·0	5·4	3·2
Mining and Quarrying	1·4	4·6	—	—
Building and Road-making	14·3	6·3	·2	—
Agriculture	2·4	2·8	·3	·8
Other Industries	15·5	8·1	10·3	5·5
Housewives	—	2·0	64·8	69·2
Retired, unoccupied, part-time	4·0	12·6	·2	6·6
Not stated	—	·2	—	—
Total	100·0	100·0	100·0	100·1

Quota samplers have sometimes expressed the view that a weak point of their method lies in the probability of industrial-occupational bias and some organizations have occasionally tried to use an industrial control. Table 2 bears out the view that there is danger of bias here. The figures show the large excess in the quota sample of persons employed in distributive, transport, public service, and building and roadmaking occupations and the correspondingly small percentage of persons employed in manufacturing. It is clear from the 1951 Census that the random sample distribution corresponds closely to the correct picture.

The aim of this part of the research was to pin-point the aspects of quota sampling which might warrant study in the main experiment. It seemed that it would be worth while to include an industrial control in part of our experiment in order to gauge the importance of differences such as those shown in Table 2.

1.4. *The Purpose of the Experiment*

It was always intended that the main part of the research would be a special experiment. The previous stages were preliminary to this and were indeed helpful in suggesting the lines the experiment should follow. The specific points on which we now sought information were:

(*a*) the extent to which the results of quota sampling were affected by setting controls additional to the basic ones (sex, age, social class);

(*b*) the extent to which the results were affected by the different types of quota assignment—i.e., independent and interrelated quotas;

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(*c*) the magnitude of variability between quota samples selected by different interviewers;

(*d*) the magnitude of differences between the results of quota and random surveys. Random sampling itself is not free from faults or possible biases but it is often the best standard available. Whenever population data are available, they of course provide the best comparisons for the sampling methods. A number of our results can be thus checked.

As by-products, which did not influence the design, we wanted information on

(*e*) the location of interviews—by street, home and place of business and the effect of location on results;

(*f*) refusals and unproductive interviews;

(*g*) the geographical spread of quota and random samples;

(*h*) the order of quota filling;

(*i*) the operation of the social class control.

In planning the experiment, we aimed at keeping close to normal operational conditions. For instance, it might have been interesting to make location of interviews one of the factors of the experiment. To do so, however, would have rendered field conditions very unusual. In another direction, our desire for a realistic experiment led us to abandon our original idea of using student interviewers. To have done so would have introduced the factors of training and experience in an accentuated form and we did not think it wise to include these here.

These are only minor examples of what is the outstanding difficulty of planning experiments in this field. It is easy enough to design academic exercises with all the characteristics of satisfactory statistical experiments; it is difficult to plan experiments which on the one hand are satisfactory from the design point of view, and, on the other, keep closely to operational practice and give results of relevance to practical survey work.

1.5. *Design and Scale of the Experiment*

The main features of the design follow from the last section. Four organizations took part in the experiment and will henceforth be referred to by numbers as indicated:

1—B.B.C. Audience Research Department.
2—British Market Research Bureau.
3—Research Services.
4—Market Information Services.

The British Institute of Public Opinion, which took part in the planning of this research, found itself unable to participate in the fieldwork of the experiment at a late stage and its place was taken at short notice by Market Information Services.

We wanted to compare the alternative types of quota assignment schemes, using "independent" and "interrelated" controls. By "independent" quotas we mean the setting of marginal totals for sexes, age-groups and social class groups separately, without any attempt to control the numbers in the sub-groups arising from their interrelation. "Interrelated" quota schemes, on the other hand, involve the proportionate representation of all such sub-groups. We were able to follow operational practice here in three out of four organizations. Organizations 2 and 3, which generally use interrelated controls, did so in the experiment. Organization 1, which always sets independent controls, did so here and was joined by organization 4—which had to deviate from its usual practice of setting interrelated controls. An assignment sheet in organization 2 might look as follows:

		Social Class					
		Highest		*Middle*		*Lowest*	
	Sex:	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Age:	20–29						
	30–44						
	45–64						
	65 +						

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

while one in organization 1 might be as follows:

Sex	
Male	
Female	

Age	
20–29	
30–44	
45–64	
65 +	

Social Class	
Highest	
Middle	
Lowest	

Each organization carried out its sampling at two "control levels". At Level I, in each case, only the three basic controls were used. At Level II, an additional control was used, and earlier stages of the research had suggested that two such controls were of interest, namely, (*a*) industrial classification of individuals and (*b*) geographical location within the town. In order to avoid confounding the difference between (*a*) and (*b*) with the assignment-scheme difference, Level (II*a*) was allocated to one of each type of organization, and so was Level II(*b*). Furthermore, we required replication at each level to enable us to study interviewer variability. As explained below, the experiment took place in three towns.

Diagrammatically, the experimental layout *in each town* may be represented as follows:

Organization	1		2		3		4	
Assignment Scheme	(independent)		(interrelated)		(interrelated)		(independent)	
Control Level	I	II(*a*)	I	II(*a*)	I	II(*b*)	I	II(*b*)
Interviewer Sample	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2

Thus, each organization carried out twelve independent quota samples, four of them in each town. Half of these were operated on only the basic controls (Control Level I), half of them on these plus an additional control. It was an essential condition of the experiment that no interviewer worked on more than one of the quota samples. It also proved possible to arrange that no one quota sample was split up among several interviewers, so that in fact each organization contributed twelve independent interviewer-samples.* As each organization had agreed to carry out approximately 1,000 quota interviews, the size of each interviewer-sample was fixed at 90, which was large enough to give reasonable representation to the various control-groups. There were thus, in all, $48 \times 90 = 4{,}320$ interviews.

1.6. *Location*

The attractive idea of a national coverage was abandoned, since the spreading of our limited resources over such a large area would have made it impossible to answer the questions we had set ourselves in this experiment. Two alternatives remained. One was to select a region such as, say, South-West England; the other was to use selected towns. The Committee decided in favour of the latter, and three towns, Birmingham, Bristol and Edinburgh, were selected. The experiment was confined to people living inside the administrative areas of each town. Anyone interviewed who was, say, visiting the town was treated as an "unproductive" interview.

It may be argued that by using three towns for this experiment the setting of quotas is made especially difficult. As far as age and sex are concerned, the basis is the same as for a national survey, namely the Registrar-General's figures. The industrial control used in the II(*a*) samples is based on official Ministry of Labour figures. There remains the social class control and here it is true that no adequate statistical basis exists for the towns. However, this is—admittedly in an accentuated form—a difficulty which is inherent in the method of quota sampling. Even with national quota surveys, there is no sound statistical basis for the control as actually employed, for

* At any rate, they are as independent as is possible to arrange—i.e., they are done by different interviewers and on assignments which are kept distinct.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

it is not generally intended to be based on purely objective criteria such as income and occupation. (Organization 3 does base its social class control on these two factors.) Whether nationally, regionally or for towns, this control is an attempt to stratify by the broadest "social-class" groups and is at best only a rough approximation. In this experiment, the organizations were free to set their own quotas and, as is shown below, they all decided not to vary their social-class quotas from town to town.

Broadly speaking, then, the quotas were set on a basis similar to normal quota sampling practice and interviewers worked under normal operating conditions,* and it seemed fair to test the operation of the method in these three towns.

1.7. *Controls and Quotas*

We turn now to a brief description of the controls which were used and the basis for the quota setting.

(a) *Age and sex*

The age grouping used was

20–29
30–44
45–64
65 +

It is similar to the grouping used in many surveys and also lends itself to census comparisons. The age and sex quotas were based on 1951 Census figures for the three towns, kindly supplied to us by the Registrars-General for England and Wales and for Scotland.

(b) *Social class*

We had at one time considered asking all organizations to use exactly the same grouping, definitions and assignments for the social class control. We decided, however, that such standardization would involve, for each organization, serious deviations from usual field practice and would render the experiment unrealistic in one of its crucial aspects. Consequently, organizations were asked to set their own quotas and use their own groupings and definitions. It is interesting to see how closely the quotas compare:

TABLE 3

Social Class Quotas used in the Experiment. (*Percentages*)

	Organization			
	1	2	3	4
Highest class . . .	5	10	8	12
Middle class	20	20	18	19
Lowest class	75	70	74	69
Total	100	100	100	100

Each organization kept to the same quotas in each town. Table 3 shows that, although the organizations use different definitions and place differing emphasis on various criteria of social class, their overall quotas are closely alike, organization 1 being the only to differ appreciably.

Organizations 3 and 4 place the greatest emphasis on objective factors such as occupation and income; in organization 1, the social class control is a subjective judgment, although with great stress on occupation. In organization 2, interviewers are told to classify respondents according to their first impression of the social type and by observing "surrounding conditions", including the type of home (if a home interview) and occupation. It is fair to say that differences between organizations are in emphasis rather than fundamental approach.

* There were two relatively minor exceptions to this. One—the fact that organization 4 here used independent quotas, and not their usual interrelated ones—has already been mentioned. The other is that organization 1 interviewers are normally required to complete a small quota in a day and not to spread a large quota over several weeks.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(c) *Industrial control*

As shown in Table 2 above, there was evidence of a pronounced "occupational-industrial" bias in the composition of quota samples and we decided to see what difference an industrial control would make to the results. At Control Level II(*a*) organizations 1 and 2 included such a control. The Ministry of Labour supplied the statistics for each town. The grouping used in the control was as follows:

Distributive trades.
Transport and communications.
Professional and miscellaneous services and public administration.
Industry and manufacture.
Not gainfully employed.

The interviewer was given a full description of these groups (reproduced in Appendix D) and instructions on how to operate the control. The grouping is, of course, a broad one and still gives interviewers scope for over-representing "favourite" industries. Thus, the inclusion of "Building and Contracting" in the "Industry and Manufacture" group led some interviewers to fill the required quota for this group by including an excessive number of building workers. A more refined grouping is desirable in practice.

(d) *Geographical control*

The analysis referred to in section 1.3 suggested the question, whether lack of geographical spread over the survey area caused bias in the results. In order to throw light on this, we controlled some of our samples geographically. In view of difficulties of demarcation and boundaries as well as of knowledge regarding the distribution of the daytime population, we decided against the setting of actual quotas. Instead, six "landmarks" were selected in each of the three towns and the Level II interviewers in the two organizations using this control (3, 4) were told to do roughly one-sixth of their quotas within walking distance of each of these landmarks. Although a crude control, this stops the interviewer doing all the fieldwork near her home or in one or two favourite spots.

1.8. *Random Samples*

Although a comparison of quota and random sampling was not our only objective, it seemed desirable to select a random sample so that comparisons could be made between the two methods and between both and any other known data. For financial reasons, the random samples had to be kept down to 360 in each town. From the point of view of sampling errors, it was unfortunate that the random samples needed to be so small, but cost was an insuperable limit. The samples were selected from the 1952 Register of Electors in the usual way. Each town sample was split into three geographically clustered thirds and one of these thirds was allocated randomly to each of the three organizations carrying out the random sample.* This was merely a way of keeping the cost of travelling low. Interviewers were required to make two recalls in the case of non-contacts; no substitutes were allowed. No interviewer who was engaged on a quota sample was used on the random samples.

1.9. *Questionnaire*

We thought that the experiment would become too complex if several questionnaires were involved, so that we had the choice of a questionnaire dealing with one subject or a "mixed-bag" type of questionnaire. Both are common in surveys and we decided in favour of the latter, believing that the findings might thus be of greater generality. Three further considerations influenced the final form. Firstly, we wanted questions of the type generally asked in quota surveys—(with the exception that direct brand-consuming questions and political questions were not to be included). Our questionnaire is broadly typical of the type to which market research quota interviewers are accustomed.– Secondly, we thought that several questions should be of

* The B.B.C. was not able to take part in the random field work, but it contributed to the cost of the random sample.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the factual, demographic type (size of household, occupation, income, etc.), because then the findings would have more general interest than answers on, say, chocolate consumption. Thirdly, we wanted to include some questions (such as the one on education) which could be compared with Census results and others (such as television ownership) on which there were other data. Our final questionnaire, reproduced in Appendix A, is a mixture of demographic questions and questions broadly relating to leisure. For convenience it was called a "Leisure Survey" questionnaire.

Before field work began, the questionnaire was pre-tested by L.S.E. students and by two of the organizations.

1.10. *Interview Record Sheets*

As noted in 1.4 above, we hoped to get from the experiment information on a number of aspects of quota sampling apart from those included as specific factors. To achieve this, interviewers had to complete record sheets as well as questionnaires. On the record sheet (reproduced in Appendix B) were entered, among other things, the location, date and time of the interview, its serial number and the age, sex and social class of the respondent. Interviewers were instructed to record all their *attempted* interviews and to give information on refusals and unproductives.

The random sample required a different form of record sheet, allowing space for callbacks. This is reproduced in Appendix C.

1.11. *Fieldwork and Organization*

The experiment took place in April–May, 1952. The arrangement was that all the fieldwork should be done within a given six-week period and with one exception* this timetable was observed. Apart from the features special to this experiment, interviewers followed their own normal practices and their usual instructions on interviewing and quota filling. These instructions vary in points of detail and emphasis from one organization to another, but not basically. Lack of space prevents us from reproducing the interviewer instructions in this paper, but stencilled copies are available on request. Interviewers were briefed by their supervisors and we were present either at the briefings of the supervisors or of the interviewers themselves. The editing, coding, tabulation and analysis of results were carried out in the Division of Research Techniques.

II. *Response Rates and Completion of Quotas*

2.1. *Response Rates*

Before proceeding to the detailed analysis of the questionnaire results, we examine the response rates for the random samples and the completion of the quotas as set.

The random samples for the three towns were completed as shown in Table 4.

TABLE 4

Completion of Random Samples, by Towns and Causes of Non-achievement

Town	*Interviews Attempted*	*Questionnaires Completed*	*Refusals*	*Away from Home or Removed*	*Other Causes of Non-contact*
	%	%	%	%	%
Birmingham . .	360 (100·0)	271 (75·3)	15 (4·2)	30 (8·3)	44 (12·2)
Bristol . . .	360 (100·0)	284 (78·9)	11 (3·1)	36 (10·0)	29 (8·1)
Edinburgh . .	355*(100·0)	253 (71·3)	9 (2·5)	48 (13·5)	45 (12·7)
Total . .	1,075 (100·0)	808 (75·2)	35 (3·3)	114 (10·6)	118 (11·0)

* Five of the 360 scheduled interviews were not attempted.

The variation from town to town was relatively small. In each town, approximately three-quarters of the interviews were achieved and the outright refusal rate was only about 3 per cent.,

* M.I.S. did its fieldwork about two months later owing to the fact, already referred to, that it took the place of B.I.P.O. at a late stage.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

but about 22 per cent. of interviews were lost through failure to contact the informant. As is made clear by the segregation of causes of non-response in the last two columns of the table, about half of the non-response rate was attributable to removals from the original address or absence on holiday or business. The other half was due to a wide variety of miscellaneous causes, ranging from no response to repeated calls, to illness or other unsuitability for interview.

One of the reasons for this low response rate was the necessity for one-third of the sample to be carried out by organization 4 two to three months after the remainder, at the peak of the holiday season. This can be seen from Table 5.

TABLE 5

Completion of Random Samples, by Organizations and Causes of Non-achievement

Organization	*Interviews Attempted*	*Questionnaires Completed*	*Refusals*	*Away from Home or Removed*	*Other Causes of Non-contact*
	%	%	%	%	%
2	355 (100·0)	276 (77·8)	11 (3·1)	38 (10·7)	30 (8·4)
3	360 (100·0)	282 (78·3)	15 (4·2)	22 (6·1)	41 (11·4)
4	360 (100·0)	250 (69·4)	9 (2·5)	54 (15·0)	47 (13·1)
Total	1,075 (100·0)	808 (75·2)	35 (3·3)	114 (10·6)	118 (11·0)

Here, as always, it is difficult to assess the likelihood of bias in the achieved random sample. The non-achievement rate is higher than in the general run of Government Social Survey enquiries and probably also slightly higher than in most commercial random samples. Nevertheless, it is unusual to achieve more than about 85 per cent. of the selected sample and this is one of the obvious difficulties of random samples in the field of human sampling. In this case, the validity of the random samples can in certain respects be checked by means of Census and other data, and the results of these comparisons are given in Part III of this paper.

Table 6 shows the number of calls which were necessary to make the successful interviews.

TABLE 6

Distribution of Numbers of Calls Necessary for a Successful Interview

Town	*Number of Calls*							
	1	%	2	%	3 *or More*	%	*Total*	%
Birmingham . . .	116	(42·8)	109	(40·2)	46	(17·0)	271	(100·0)
Bristol	129	(45·4)	112	(39·4)	43	(15·1)	284	(99·9)
Edinburgh	110	(43·5)	99	(39·1)	44	(17·4)	253	(100·0)
Total	355	(43·9)	320	(39·6)	133	(16·5)	808	(100·0)

In this respect, also, there was little variation between the three towns.

For the quota samples, of course, the question of failure to obtain the specified number of interviews does not arise in the same way, since an interviewer continues operations until the assignment is fulfilled. In practice, there are often minor deviations from the exact numbers to be obtained in the various cells of the quota assignments, but these are usually unimportant, and they were so in this case. In addition, we suffered some postal losses in transit. The gross effect of these causes was a loss of 44 out of 4,320 interviews, or about 1 per cent.

As a result of the use of interview record sheets, we know the recorded refusal rate of the quota samples to have been about 8 per cent. It must be remembered that this figure is in terms of *recorded* attempted interviews: the actual refusal rate will certainly be higher. Even as it stands, it is more than double that of the random samples, and presumably reflects the stresses of interviewing outside the home. It is also worth noting that in addition about 9 per cent. of all recorded attempted interviews were "unproductive", i.e., the respondents did not fit into the required control groups.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2.2. Independent and Interrelated Quota Schemes

A point of interest which may be examined at this stage is the difference in the constitution of samples obtained by the two contrasting assignment schemes in quota sampling, which were explained in part I.

The rationale of independent-quota setting is that it gives the interviewer more freedom in filling his assignment, and consequently reduces interviewing costs. However, this freedom and economy is purchased at the expense of less control of the make-up of the sample. It has sometimes been suggested that, in the long run at least, the freedom given to the independent-type interviewer of filling the main body of quota cells as he pleases, subject only to the assigned marginal totals, makes little or no difference to the constitution of the sample. This was easily tested.

The relative frequencies assigned to the cells of the inter-related samples were, so far as sex and age figures are concerned, based on the census results. These relative frequencies may be used as a set of theoretical frequencies to form the basis of a chi-squared test of goodness of fit of the achieved frequencies in the 24 cells.*

Table 7 shows the actual frequencies obtained in the sub-groups of the sex-age-social class classification by the combined independent-scheme samples, together with the expected frequencies calculated on the basis of the interrelated-scheme assignments.

TABLE 7

Observed Frequencies in Combined Independent-scheme Samples with Expected (Interrelated Scheme) Frequencies in Brackets

Social Class	*Sex*	*Age* 20–29	30–44	45–64	65 +
Highest . .	M	8 (17·6)	34 (23·5)	30 (28·4)	18 (15·7)
	F	6 (20·6)	45 (24·6)	39 (42·2)	17 (18·7)
Middle . . .	M	40 (37·3)	68 (62·8)	59 (64·9)	20 (24·6)
	F	51 (38·4)	92 (65·8)	67 (71·7)	31 (38·4)
Lowest . . .	M	140 (149·3)	220 (228·9)	195 (230·8)	124 (85·5)
	F	150 (161·0)	261 (256·2)	305 (277·0)	101 (137·4)

Three two-way tables can be formed from Table 7 by summing over one of the criteria of classification, and each of these tables, as well as Table 7 itself, may be tested for goodness of fit to the corrected frequencies. To save space, we omit these tables, and give only our results.

Table	*Value of Chi-squared*	*D.F.*	*Probability of Exceeding this Value*
Sex × Age	36·9	7	$P < \cdot 001$
Sex × Social Class . . .	4·3	5	$\cdot 50 < P < \cdot 60$
Age × Social Class . . .	50·7	11	$P < \cdot 001$
Sex × Age × Social Class . .	93·5	23	$P < \cdot 001$

Only the Sex × Social Class classification does not yield a highly significant deviation from expectation. The Social Class Control being so loosely drawn, one might have expected the Sex × Age Table, which is independent of it, to show up better than the others, but this is not the case. As is to be expected, the 3-way table is furthest from expectation, and the contributions of the individual cells make it clear that the main discrepancies were: (*a*) the interviewing of too few men and women of the highest social class in the under-30 age group; and the compensatingly large numbers in the next age-group; (*b*) the excess of women of the middle social class in the under-30 and 30–44 age groups; and (*c*) in the lowest social class, the deficiency of men and excess of women in the 45–64 age group, and the converse excess of men and deficiency of women

* The achieved frequencies of the interrelated-scheme samples differ from the assigned frequencies only by the minor variations mentioned at the end of section 2.1 above, but, as a routine check to chi-squared tests were carried out and, as expected, none was found to be significant.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

in the 65 and over group. Between them, these tendencies account for over 90 per cent. of the observed value of chi-squared.

It will be remembered that only half of the independent-scheme samples were carried out at Control Level I, i.e., without further controls, and it may be objected that the operation of a geographical or, more particularly, an industrial control would be sufficient to distort the interviewers' performance. Although this may have been the case to some extent, we found that when the analysis described in the last section was repeated using only the Level I half of the independent-scheme samples, there being twelve samples concerned, the conclusions reached were quite unchanged. For the sake of completeness, we record the results.

Table	*Value of Chi-squared*	*D.F.*	*Probability of Exceeding this Value*
Sex × Age	16·8	7	$\cdot 01 < P < \cdot 05$
Sex × Social Class	0·8	5	$\cdot 95 < P < \cdot 99$
Age × Social Class	26·6	11	$\cdot 001 < P < \cdot 01$
Sex × Age × Social Class	41·3	23	$\cdot 01 < P < \cdot 05$

These results establish that so far as the basic quota controls are concerned, independent-scheme quota samples are not constituted similarly to interrelated-scheme samples. Our purpose is to investigate whether such differences in the constitution of the samples are reflected to any appreciable extent in the answers to the questionnaire. This is considered in Part III of this paper.

2.3. *Age-spread within Quota Cells*

We now turn to another aspect of quota filling. It is a common criticism of quota sampling that, while the numbers in the broad control groupings are fixed according to known or estimated population figures, the spread of respondents within these groupings may be inadequate. In particular, it is sometimes said that samples may under-represent very old respondents and also those at extremes of the social scale.

In the case of social class, it is not possible to do any precise splitting-up of the broad groups and one can only judge the spread by studying the answers to questions on income, occupation and so forth. The age-control lends itself to a more direct check.

The numbers falling into any of the control groups may be split into 5-year groupings,* and the frequencies tested by chi-squared against the relative frequencies provided by the census results.

This was done in each age-control group and town, for each of the four following independent combinations† of samples:

(*a*) all 4 Level I independent-scheme samples;
(*b*) all 4 Level I interrelated-scheme samples;
(*c*) all 4 Level II industrial control samples;
(*d*) all 4 Level II geographical control samples.

From the 48 values of chi-squared found, the corresponding probability levels of the test were tabulated in a broad grouping as in Table 8.

TABLE 8

Distribution of Probability P *of Exceeding the Observed Value of Chi-squared in* 48 *Tests of Age-spread within Quota Cells*

P	0 –	·2 –	·4 –	·6 –	·8 –	*Total*
Number of cases	23	9	4	7	5	48

On the null hypothesis, these P values should be distributed uniformly in the interval 0–1, and this fact may be used to test Table 8, again by the chi-squared test.‡ We find a chi-squared

* In the "65 and over" groups, ages "80 and over" were taken together,

† Some combination of the basic samples was necessary to satisfy the requirements of the chi-squared test.

‡ This method of combining independent tests of significance is used here in preference to the well-known exact test because Table 8 is immediately convincing. The exact test leads to the same conclusion.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

value of 24·9 for 4 degrees of freedom, a highly significant result, and we infer that the age-distribution of the quota samples within age-control groups cannot be regarded as having arisen from random sampling within the groups.

The random samples may be tested in the same way, but here there are only 12 cases involved (four age-groups in each of three towns). Despite the inadequacy of the chi-squared approximation for expected frequencies as low as in this case, the chi-squared value of 0·5 for 4 degrees of freedom, with a probability level of about ·3, is very satisfactory.

None of the 12 random sample values of P lies beyond the ·05 point, while 11 of the 48 quota sample values do so. Looking at these in more detail, we find that they are evenly distributed over the two control levels, and that the distributions over towns and age-groups are as shown in Table 9.

TABLE 9

Distribution of Significant Values Over (a) *Towns, and* (b) *Age-groups*

(a) *Town*	*Number of Values*	(b) *Age Group*	*Number of Values*
Birmingham . . .	0	20–29 . . .	1
Bristol	4	30–44 . . .	2
Edinburgh . . .	7	45–64 . . .	4
		65– . . .	4

The statistical significance of the result in section (*a*) of the table is beyond doubt: the probability, in a multinomial experiment with equal probabilities, of any of three cells remaining empty after eleven trials is 3^{-10} or about ·000017. The result is not easily explained, for all organizations and levels were equally represented in each town. One can only suppose that the greater size of Birmingham (about two-and-a-half times as large as each of the others) made for easier spreading of respondents over control groups, but in view of the large size of the two other towns, we have no great faith in this suggestion.

In section (*b*) of Table 9 the result shown is not statistically significant, although there is an evident tendency for the discrepancies to occur in the two higher age control groups, and this leads to an interesting point.

The high chi-squared values in the age-spread tests were a reflection of a general tendency to over-represent the lowest ages within age-control groups, and under-represent the higher ages. Table 10 shows, for all 48 samples combined, the expected and achieved numbers in the constituent 5-year groups of each quota control group.

Apart from the lowest age-control group, the pattern is the same throughout. More especially, the chi-squared values in the two highest control groups are extremely significant. There is probably no simple explanation of this pattern, and it may be accounted for by two related factors. In the first place, the younger people in these control groups may be more easily found by the interviewer. Secondly, and resulting partly from this, it is possible that the pattern is partly due to "quota fitting". In other words, an interviewer needing somebody in the 65 and over group, and finding (towards the end of an interview) that the respondent is, say, 63, records his age as 65 or 66. It may be objected that there is no reason why a false age of 65 should be recorded rather than, say, 74, which would achieve the same purpose. However, there is evidence that interviewers tend to select the nearest ages in the adjacent groups when practising "quota fitting". An example is the national quota sample survey to which reference was made in Section 1.3. In that survey, the quota age-groups were 25–34, 35–44 . . . 65–74 and Table 11 shows the frequency distribution of the recorded *last digit* of age stated, for men and women separately. It also gives the comparable Census figures.

There is an evident slight tendency for women to round their age to a final zero, but clearly nothing of this kind can account for the quota sample frequency at digit 5, or the frequency at digit 4 for men—the tendency for women here is less marked. As far as Table 11 is concerned, the only satisfactory explanation is that quota fitting took the form of selecting the nearest ages in adjacent quota groups.

It is thus not unreasonable to suppose that this played some part in the results of Table 10 also. However, the fact that over-representation there occurs only in the lower groups, and the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 10

Expected and Achieved Numbers in the Constituent Five-year Groups of the Quota Age-control Groups, for all Quota Samples Combined

(a) 20–29 *group*	20–24	25–29	*Total*		
Expected . . .	428	452	880		
Achieved . . .	414	466	880		
Chi-squared = 0·9 for 1 d.f.					
(b) 30–44 *group*	30–34	35–39	40–44	*Total*	
Expected . . .	435	443	457	1,335	
Achieved . . .	473	451	411	1,335	
Chi-squared = 8·1 for 2 d.f.*					
(c) 45–64 *group*	45–49	50–54	55–59	60–64	*Total*
Expected . . .	407	381	352	279	1,419
Achieved . . .	505	393	273	248	1,419
Chi-squared = 45·4 for 3 d.f.†					
(d) 65 *and over group*	65–69	70–74	75–79	80–84	*Total*
Expected . . .	231	188	128	85	632
Achieved . . .	298	182	103	49	632
Chi-squared = 47·3 for 3 d.f.†					

* Denotes significance at 5 per cent. level.
† Denotes significance at 0·1 per cent. level.

TABLE 11

Frequency Distribution of Recorded Last Digit of Age Stated, for (a) *Men,* (b) *Women. B.M.R.B. Quota Sample and Census*

Last Digit	(a) *Men*			(b) *Women*		
	B.M.R.B. Sample		*Census*	*B.M.R.B. Sample*		*Census*
	Frequency	%	%	*Frequency*	%	%
5	520	16·6	10·6	457	14·4	10·4
6	333	10·6	10·4	311	9·8	10·4
7	287	9·2	10·3	304	9·6	10·3
8	279	8·9	10·5	303	9·5	10·4
9	265	8·5	10·6	320	10·1	10·3
0	293	9·4	10·6	375	11·8	10·7
1	264	8·4	9·9	275	8·7	10·0
2	229	7·3	9·3	276	8·7	9·4
3	277	8·8	8·7	253	8·0	9·1
4	386	12·3	9·0	305	9·6	9·1
Total	3,133	100·0	99·9	3,179	100·2	100·1

reverse in the higher groups, rules out a simple explanation of the kind that suffices for Table 11. We hope to investigate this matter more closely in a later paper, with special reference to the influence of the order of quota filling.

III. *The Questionnaire Results*

3.1 *Comparison of Random and Quota Sample Results*

Validity checks.—One of the purposes of the experiment was to compare the results obtained from the different types of quota samples with those from random samples selected from electoral registers in the ordinary way. Ideally, one would have liked to check all the results from both

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

methods of sampling against known population data. As everyone working in this field knows, however, validity checks are difficult to find, particularly when one wants to do more than merely check national figures. In this experiment, we are concerned with single towns and, in order to have reliable checks, we included several questions on which the 1951 Census yielded information. Even these must not be regarded as entirely satisfactory checks; the Census was taken a year before the date of this experiment (a difference which, on the demographic questions concerned, probably matters relatively little) and there are, necessarily, slight differences in definitions and

TABLE 12

Distribution by Sex and Age. Census and Random Samples (Aged 21 and Over) (Percentages)

(a) *Sex*

Sex	*Birmingham*		*Bristol*		*Edinburgh*	
	Census	*Random Samples*	*Census*	*Random Samples*	*Census*	*Random Samples*
Male . . .	48·3	45·4	46·5	48·4	42·7	40·0
Female . .	51·7	54·6	53·5	51·6	57·3	60·0
Total . . .	100·0	100·0	100·0	100·0	100·0	100·0

(b) *Males by Age*

Age	*Birmingham*		*Bristol*		*Edinburgh*	
	Census	*Random Samples*	*Census*	*Random Samples*	*Census*	*Random Samples*
21–29 . . .	21·5	11·4*	18·4	17·5	18·5	4·5*
30–44 . . .	36·1	35·0	32·0	32·1	31·6	31·5
45–64 . . .	31·2	35·8	35·7	33·6	35·3	39·4
65 + . . .	11·2	17·8	13·9	16·8	14·6	24·6*
Total . . .	100·0	100·0	100·0	100·0	100·0	100·0

(c) *Females by Age*

Age	*Birmingham*		*Bristol*		*Edinburgh*	
	Census	*Random Samples*	*Census*	*Random Samples*	*Census*	*Random Samples*
21–29 . . .	19·6	15·6	16·1	20·5	16·8	17·8
30–44 . . .	33·1	31·2	30·4	30·1	29·5	29·5
45–64 . . .	32·3	34·4	35·5	25·4*	35·3	41·8
65 + . . .	15·0	18·8	18·0	24·0	18·4	10·9*
Total . . .	100·0	100·0	100·0	100·0	100·0	100·0

Asterisks indicate that the difference between random sample and Census figures exceeds twice the standard error.

interpretation in the sources of the two sets of figures. However, the Census figures undoubtedly provide very close checks.†

We also included questions on library membership and ownership of cars, television sets and telephones, for all of which some population facts for the three towns are available. Here there are more serious difficulties of definition, time and area, and while we believe that the figures are useful checks on our results, they are far from being exact ones.

† They themselves are based on a 1 per cent. sample of Census returns. The 1 per cent. sample numbers were about 4,500 for Bristol and Edinburgh, and about 11,000 for Birmingham. This means that the 1 per cent. sample errors would be *at most* about one-quarter of those encountered in the experiment, and generally less than this, and they have consequently been neglected.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

On several other questions, we could have compared our findings with known national or regional figures, or with results from past surveys, but we did not think it worth-while to use check figures which did not refer specifically to our three towns.

The random sample and re-weighting.—As explained above, we had to be satisfied with a random sample of 360 names in each town, so that the random results are subject to a substantial sampling error. In addition, the non-achievement rate of 25 per cent. means that we must look for evidence of bias in the composition of the random samples. With this end in view, we compare in Table 12 the sex and age composition of the random samples with the Census figures; the quota samples are, of course, controlled on these factors.

The random sample sex percentages differ from the Census figures by less than one standard error; the slight under-representation of males in Birmingham and Edinburgh is due to non-response and is not uncommon in random samples. The age-distributions of the random samples differ markedly from the population figures, and here again the main cause is probably the high non-achievement rate. It must be remembered, however, that the samples are small; in fact, only a few of the age differences differ from the Census figures by more than twice the standard error.*

It is not necessary to study these figures further. They show that, where answers are correlated with age and sex, there might be danger of bias. Since many questions are likely to be so correlated, we have re-weighted the random results by age and sex. In what follows, we shall give *both* the unweighted and weighted random sample figures. This is, in effect, a stratification after selection and serves to compensate non-response bias due to age-sex group differences though it does not, of course, eliminate any biases *within* age and sex groups due to non-achievement of the designated sample. One cannot be sure that such re-weighting may not actually make the results *less* accurate. If, say, the young males in the sample are untypical of those whom it was not possible to get into the sample, the re-weighting will give this unrepresentativeness greater weight and may result in less accurate estimates. Some of the tables below suggest that this has happened on some questions.

Form of presentation.—We shall now present the results on the individual questions, distinguishing random unweighted (*a*) and random weighted (*b*) figures and the four parts of the quota samples—namely Control Level I (independent quotas), C.L. I (interrelated quotas), C.L. II (industrial control) and C.L. II (geographical control). They will be referred to as I*a*, I*b*, II*a* and II*b* respectively. The organizations concerned in these four parts of the quota samples are respectively 1 and 4; 2 and 3; 1 and 2; 3 and 4.

The sample numbers on which percentages and averages for the main questions are based are:

	Random Samples	*Quota Samples*			
		*I*a	*I*b	*II*a	*II*b
Birmingham . . .	271	368	357	362	345
Bristol	284	357	359	354	353
Edinburgh . . .	253	347	360	361	393

In the case of sub-questions, sample numbers will be given in the tables.

Comparison with Census figures.—We are able to make comparisons with Census data on occupation,† education, marital status and household composition. All four are useful indicators of sample representativeness, the first two bearing closely on the social composition of a sample, the others on its demographic characteristics.

Table 13 shows the occupational distributions of the samples together with the Census figures.

* In Edinburgh the ages of 12 men and 23 women were not recorded by an interviewer; we have had to assume that these would have been distributed evenly over the age-groups.

† The classification is effectively an industrial/occupational one. For brevity, it will be referred to as "occupational". In coding occupations we have followed the definitions given in the Census volumes. The figures in these volumes are given for the population aged 15 and over; in order to make them comparable with our results, we have adjusted them on the basis of the national figures given in the Census—i.e., we have deducted from the number for a given occupation a proportion equal to the national proportion of persons in that occupation aged 15–19. Only a small percentage is involved and the estimates thus arrived at are certain to be very close to the actual figures.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

TABLE 13

Distribution by Occupation. Census and Samples

Males (Aged 20 and Over.) (Percentages)*

	Birmingham							Bristol							Edinburgh						
	Census	Random Samples		Quota Samples				Census	Random Samples		Quota Samples				Census	Random Samples		Quota Samples			
		(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*		(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*		(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*
Manufacturing	47·2	52·9	54·4	36·2	26·0	45·3	27·6	31·6	25·0	28·4	14·9	14·4	37·1	24·4	27·8	25·5	26·9	22·8	28·8	24·4	26·2
Building, Contracting	5·8	1·7	1·8	5·7	7·7	6·4	9·6	7·7	5·1	5·4	10·7	8·4	9·4	7·9	6·8	6·1	7·7	5·4	7·2	4·5	10·1
Administrators, Directors	3·0	2·5	3·1	0·6	3·5	5·2	1·3	3·1	2·9	3·5	3·6	0·6	3·1	1·2	2·3	2·0	2·7	—	2·0	3·8	2·7
Transport, Communications	8·9	9·1	10·1	5·2	16·6	8·1	16·0	13·3	15·4	14·2	13·7	16·2	8·2	15·2	14·2	8·2	7·2	15·4	15·7	9·0	10·1
Commerce, Finance	8·2	10·7	12·1	11·5	10·6	7·6	15·4	8·9	10·3	11·0	13·7	23·4	7·5	8·5	9·8	12·2	16·7	8·7	15·0	7·7	10·7
Professional and Technical	4·4	3·3	3·3	8·0	5·9	1·2	5·1	5·2	2·2	2·1	4·2	4·2	1·9	4·9	5·8	4·1	2·9	4·0	2·6	7·1	2·7
Personal Service	2·5	4·1	4·1	3·4	3·5	2·9	2·6	2·4	4·4	5·8	3·6	6·0	4·4	4·9	4·1	2·0	2·1	6·7	2·6	10·3	4·7
Clerks, Typists	5·1	3·3	3·4	5·7	10·6	2·3	2·6	7·0	8·1	8·3	4·8	4·8	5·0	6·7	7·4	6·1	6·8	11·4	7·8	4·5	5·4
Other	6·5	5·8	5·0	8·8	8·5	6·5	8·3	7·4	10·4	10·6	13·0	10·0	12·1	7·4	8·8	10·3	10·2	10·2	9·8	13·3	10·0
Retired, not gainfully occupied	8·4	6·6	2·7	14·9	7·1	14·5	11·5	13·4	16·2	10·7	17·8	12·0	11·3	18·9	13·0	23·5	16·8	15·4	8·5	15·4	17·4
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

Females (Aged 20 and Over.) (Percentages)

Manufacturing	14·1	11·3	11·7	12·0	6·9	15·3	5·8	7·5	8·1	7·9	1·1	2·6	14·7	2·1	4·9	1·3	1·5	3·0	7·7	12·7	0·5
Commerce, Finance	3·9	5·3	5·4	3·6	6·9	5·8	12·6	2·9	5·4	6·3	5·8	13·2	3·7	7·4	3·9	3·9	3·5	7·1	14·0	4·9	3·9
Professional, Technical	2·5	2·7	2·7	5·2	10·6	3·2	4·8	2·4	3·4	3·7	1·6	1·6	0·5	4·3	4·7	3·9	3·9	2·0	0·5	2·9	4·4
Personal Service	8·4	10·0	11·2	8·3	20·2	9·5	11·1	6·0	12·8	14·9	12·2	11·1	12·1	12·2	10·5	15·5	15·4	19·7	13·5	15·6	16·2
Clerks, Typists	8·3	7·3	8·2	14·1	12·2	3·2	6·9	5·7	5·4	4·7	7·9	3·2	7·4	4·8	7·8	8·4	7·9	11·6	11·1	8·8	5·9
Other	4·2	2·1	2·2	1·5	6·4	3·5	2·6	2·0	3·4	3·7	1·0	·6	2·1	2·2	1·9	3·1	2·6	1·6	2·5	2·4	1·0
Retired, not gainfully occupied	58·6	61·3	58·6	55·3	36·8	59·5	56·2	73·5	61·5	58·8	70·4	67·7	59·5	67·0	66·3	63·9	65·2	55·0	50·7	52·7	68·1
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

* As the random samples were drawn from the electoral registers, "20 and over" should be interpreted as covering that part of the population included in the registers at the sampling date. Practically none of the random sample respondents were under 21, while 2 per cent. of the quota sample respondents were.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar
Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

Male occupation.—First of all, it is worth testing the goodness of fit of these various distributions by the χ^2 test, using the Census figures as the expected frequencies.

The χ^2 values are:

Town	*Random Samples*	*Quota Samples*			
		*I*a	*I*b	*II*a	*II*b
Birmingham . . .	8·46	20·42	42·73	10·97	40·17
Bristol	10·24	33·35	70·24	16·22	11·85
Edinburgh . . .	13·54	11·88	10·33	28·27	9·35

The 5 per cent. and 1 per cent. values (for 8 d.f.)* of χ^2 are 15·57 and 20·09 respectively. None of the random distributions differs significantly from the Census results, while seven of the twelve sets of quota results do so, some of them very markedly. The high value of χ^2 for the industrially-controlled samples in Edinburgh calls for comment; it is due, as inspection of Table 13 shows, to the unduly large number of Personal Service workers included.

Looking at the figures themselves, we note that the quota samples under-represent workers in manufacturing industries. In Birmingham, for instance, the average for the quota samples—excluding those with an industrial control—is 30 per cent. compared with the Census figure of 47 per cent. and the random figure of 54 per cent. The corresponding proportions for Bristol are 18 per cent., 32 per cent. and 28 per cent. In Bristol, four interviewers (all working on only basic quota controls) included no manufacturing workers at all. Workers in transport, building and contracting are over-represented in the quota samples, as are those in the commerce and finance group, which includes distributive workers. (Note, for instance, the figure of 23 per. cent found by the I*b* samples in Bristol, as compared with a Census percentage of 9 per cent.) The quota samples, in general, are high for the "retired and not gainfully employed" group.

The random sample results are much closer to the Census figures, though there is unevenness between the towns. Transport workers are on the whole under-represented, while there are too many workers in commerce and finance, as in the quota samples. The effect of re-weighting is slight; the most marked changes are an increase in the numbers in manufacturing industries and, as was to be expected, a decrease in those in the retired group.

Our conclusion is that, if in a quota survey it is desirable to make the samples broadly representative by occupation, it would be advisable to set upper limits to the numbers of distributive, building and transport workers to be included and a lower limit for the number of manufacturing workers.

Female occupations.—The χ^2 values obtained were:

Town	*Random Samples*	*Quota Samples*			
		*I*a	*I*b	*II*a	*II*b
Birmingham . . .	5·40	16·42	109·01	8·38	52·75
Bristol	19·58	31·82	87·61	34·42	36·24
Edinburgh . . .	9·57	32·72	77·08	38·99	16·21

The 5 per cent. and 1 per cent. values of χ^2 (for, in this case, 6 d.f.) are 12·59 and 16·81 respectively. One of the random samples and all but one of the quota samples differ significantly from the expected values, some of them very markedly indeed. This is partly due to variations in the number of housewives included in the samples.

The figures for females are less consistent as between towns. The most notable feature is the high number in Personal Service both in the random and the quota samples. Some of the individual figures for the group including the distributive workers are very high—for instance, the 13 per cent. in the interrelated samples in Bristol, as compared with the Census figure of 3 per cent. Another extreme figure is that of only 37 per cent.—in Birmingham—in the "retired and not gainfully employed" group.† This is due to a very low percentage of housewives in these samples. In all three towns the "manufacturing" percentage found by the industrially-controlled quota samples is too high; it appears that, for women, the industrial control somewhat over-corrected the usual tendency of quota samples. In Bristol and Edinburgh, both the random and

* Two of the groups in the table were combined for the test.
† The Census figure for this category in Bristol is surprisingly high.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the quota II*a* samples included too few women in the "retired and not gainfully employed" category.

We have singled out only a few of the discrepancies from these occupation tables. The occupational distributions of the quota samples differ markedly from the Census figures; those of the random samples, with one exception, do not.

Education.—It has sometimes been suggested that quota samples tend to be biased in favour of the more educated sections of the population. In order to test this, we included in our questionnaire the education question asked in the Census: "At what age did you finally stop receiving full-time education?" Table 14 gives the percentage of persons who finished education at given ages.* The pattern is much the same in the three towns and the results are combined.†

TABLE 14

Distribution by Age at which Full-time Education Ceased. Census and Samples. (Aged 20 and Over.) (Percentages)

Age at which Full-time Education Ceased	*Males*							*Females*						
	Census	*Random Samples*		*Quota Samples*				*Census*	*Random Samples*		*Quota Samples*			
		(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*		(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*
Below 15 . .	81·1	78·1	76·3	69·2	68·2	74·9	70·6	77·3	76·7	79·0	63·6	66·5	74·0	69·3
15	6·0	11·3	12·0	10·7	11·5	7·9	9·8	7·9	5·7	4·9	13·9	12·0	11·0	13·4
16	7·2	4·9	6·5	9·5	10·1	9·8	8·8	7·0	7·2	6·5	10·6	7·8	5·1	8·5
17–19 . . .	3·5	4·7	3·9	6·3	5·3	4·7	6·2	4·2	6·6	5·4	8·7	7·9	6·9	8·0
20 and over . .	2·2	1·0	1·3	4·4	4·9	2·7	4·5	3·6	3·9	4·2	3·2	5·9	3·1	·8
Total . .	100·0	100·0	100·0	100·1	100·0	100·0	99·9	100·0	100·1	100·0	100·0	100·1	100·1	100·0

The figures tell a clear story. There is a pronounced tendency in the quota samples to underrepresent those who finished education before the age of 15. If one includes the figure for age 15 itself, the results for females come more closely into line, but for males they still fall far short of the Census or Random proportions. It is interesting that the industrial control goes some way to correct this tendency; there is little difference between the independent and interrelated quota samples. The random samples are close to the Census results and—unlike all the quota samples, except those that use the industrial control—well within two standard errors. In short, our results support the hypothesis that quota samples get too educated a cross-section of the population. If and when this matters is another question, but it is clear that in surveys closely related to education—such as readership surveys—this danger of bias cannot be ignored and that, if possible, some kind of educational control should be used.

Marital status.—Table 15 shows the breakdown of the Census and sample figures by marital status.

On the whole, the quota samples give a more accurate distribution by marital status than the random samples. This is particularly so for males. The random samples have too few single men, and as this deficiency is accentuated by the weighting, it cannot be attributed to different age distributions for single and married persons and is more probably due to non-response.‡ It is interesting to note that the tendency in the quota samples is in the opposite direction, namely to have too few married men. The samples based on only the basic controls are somewhat closer to the Census results than those with an additional control. The interrelated samples, in particular, are very close to them in all three towns, while the II*b* samples are uniformly deficient in married men.

As in the case of occupation, so here too the figures for females are less consistent, both between towns and samples. The random samples, with the exception of Bristol, have too many married

* As the Census question was not asked of "retired persons or persons not following an occupation for payment or profit", we eliminated such persons from our analysis, so that the figures in Table 14 are strictly comparable.

† In combining the results for the three towns, here and in most of the tables that follow, we had to decide whether to take an unweighted mean or to weight the results for the three towns by population size. On balance, we thought the second alternative preferable and all the combined estimates, as well as the standard errors, are weighted in this way.

‡ See authors' reply to discussion.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 15

Distribution by Marital Status. Census and Samples. (Aged 20 and Over.)

(Percentages)

Marital Status	Males							Females						
	Census	Random Samples		Quota Samples				Census	Random Samples		Quota Samples			
		(a)	(b)	Ia	Ib	IIa	IIb		(a)	(b)	Ia	Ib	IIa	IIb
Birmingham														
Married	73·6	78·9	76·1	64·9	72·5	74·9	63·7	68·1	72·3	73·7	67·4	60·0	78·6	68·6
Single	20·9	14·6	18·9	23·6	18·5	19·4	24·8	17·8	12·2	12·5	20·7	23·7	11·2	18·1
Other	5·5	6·5	5·0	11·5	9·0	5·7	11·5	14·1	15·5	13·8	11·9	16·3	10·2	13·3
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
Bristol														
Married	77·2	78·1	78·9	75·9	77·4	80·2	67·1	68·4	59·6	60·3	74·3	75·4	63·0	64·9
Single	18·0	13·9	14·2	19·9	17·2	16·1	23·2	17·0	23·3	24·2	13·1	13·6	17·2	20·2
Other	4·8	8·0	6·9	4·2	5·4	3·7	9·7	14·6	17·1	15·5	12·6	11·0	19·8	14·9
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
Edinburgh														
Married	71·5	83·2	82·4	70·9	69·1	63·6	67·8	55·3	58·6	53·2	53·1	51·9	55·6	70·5
Single	22·4	8·9	11·6	22·5	23·0	28·6	24·5	28·3	23·0	26·8	26·0	30·8	29·0	17·1
Other	6·1	7·9	6·0	6·6	7·9	7·8	7·7	16·4	18·4	20·0	20·9	17·3	15·4	12·4
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

women; some of the groups of quota samples differ very markedly from Census distributions, notably the geographically controlled samples in Edinburgh, for which the Census percentage for married women is 55 per cent., that of the samples 70 per cent. These variations are partly accounted for by the freedom of interviewers to determine the proportion of housewives among the women in their samples.

Household composition.—The last comparison with Census figures is on household composition.* There is a serious difficulty here, in that the Census refers to the population as constituted at a specified time, without reference to "normal" household groupings, to which our samples refer. It is difficult to estimate the extent of the discrepancies arising from this source, but it seems likely that they are considerable, particularly as regards the percentage of 1-person households.

Table 16 gives two sets of sample figures. In Table 16A are shown the percentages of individuals, in the various samples, coming from households of a given size. There are no Census figures for comparison here, as the Census distributions are given in terms of households, not individuals. In order to put the sample figures on the same basis, we must re-weight them to give each household the same chance of inclusion in the sample. For the random samples this is straight forward. They are samples of individuals selected from the electoral register, so that any household has a probability of inclusion proportional to the number of members of the household appearing in the register. To equalize household probabilities, the results have been weighted by the reciprocals of these numbers.†

The quota samples are also samples of individuals, but here the probabilities of selection are not known. It is reasonable to suppose that, the more adults in a household, the greater the chance of that household being selected, but one cannot be more precise than this. However, in order to put the quota and random figures on a broadly comparable basis, we have weighted the quota results in a similar manner, i.e., according to the reciprocal of the number of adults in the household. The weighted sets of figures for random and quota samples are given in Table 16B. These figures are, subject to the qualification pointed out above, comparable with the Census proportions, which are given in Table 16C.

* The Census figures refer to private households, i.e., they exclude persons living in hotels, institutions, etc. We have therefore similarly excluded them from the sample figures.

† For Table 16 the weighting by age and sex, designed to offset random sample non-response bias has not been carried out.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 16A

Distribution of Persons by Size of Their Households. Random and Quota Samples. (Percentages)

Household Size	Birmingham					Bristol					Edinburgh				
	Random Samples	Quota Samples				Random Samples	Quota Samples				Random Samples	Quota Samples			
		Ia	Ib	IIa	IIb		Ia	Ib	IIa	IIb		Ia	Ib	IIa	IIb
1	3·8	10·7	2·4	1·9	9·8	5·5	3·4	6·1	7·2	9·0	5·8	6·2	9·6	8·1	6·5
2	28·9	19·6	24·8	22·1	19·6	22·7	26·2	23·4	25·8	22·1	27·0	20·8	21·0	24·6	25·4
3	27·4	29·7	26·6	28·1	23·9	28·5	26·2	25·5	26·1	25·5	29·9	28·0	25·9	25·7	27·2
4	16·6	20·4	21·9	25·0	24·9	26·0	22·2	23·2	23·8	23·4	21·4	20·8	21·9	19·2	21·9
5 +	23·3	19·6	24·3	22·9	21·8	17·4	22·0	21·8	17·1	20·0	15·9	24·2	21·6	22·4	19·0
Total	100·0	100·0	100·0	100·0	100·0	100·1	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

TABLE 16B

Distribution of Households by Size. Random and Quota Samples. (Percentages)

Household Size	Birmingham					Bristol					Edinburgh				
	Random Samples	Quota Samples				Random Samples	Quota Samples				Random Samples	Quota Samples			
		Ia	Ib	IIa	IIb		Ia	Ib	IIa	IIb		Ia	Ib	IIa	IIb
1	6·8	22·4	5·6	4·6	20·5	11·5	7·6	13·2	15·2	18·4	12·1	15·4	20·1	17·0	13·5
2	32·7	20·9	29·5	26·0	21·8	25·9	30·2	25·8	28·9	23·7	29·5	28·3	23·1	27·0	27·3
3	26·2	27·3	27·1	27·8	21·6	26·8	24·8	23·9	23·0	23·9	27·4	23·2	23·8	23·0	25·2
4	14·7	16·4	18·6	22·4	20·1	22·9	20·2	20·1	20·6	20·3	18·5	18·3	17·7	16·2	19·5
5 +	19·6	13·0	19·2	19·2	16·0	12·9	17·2	17·0	12·3	13·7	12·5	14·8	15·3	16·8	14·5
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

TABLE 16C

Distribution of Households by Size. Census. (Percentages)

Household Size	Birmingham	Bristol	Edinburgh
1	9·9	11·2	13·7
2	25·8	27·2	27·8
3	24·5	25·9	21·9
4	20·1	18·2	20·0
5 +	19·7	17·5	16·6
Total	100·0	100·0	100·0

Table 16A shows some sizeable differences between the household size distributions for the random and quota samples. Most noticeable is the higher proportion of quota respondents coming from 1-person households. Although this does not appear in the table, there is a striking variation between quota sample interviewers in the proportion of 1-person households they select. Two of them had no 1-person households at all and another ten had less than three in their samples of 90.

The weighting of the random sample figures to ensure equal chance of inclusion for every household has brought the proportions of 1-person households broadly into line, at least for Bristol and Edinburgh. That the quota sample re-weighting for the same purpose rests on more dubious assumptions is indicated by the figures themselves. The weighted quota results are by no means always closer to the Census distribution than are the unweighted results. In other words, in some cases the quota samples of individuals give a more accurate distribution by household size, when no allowance is made for the varying probability of inclusion for households of different size. In fact, this probability does not vary directly with the number of adults in the household, since a proportion of each quota sample consists of home interviews with (presumably) the dwelling as the sampling unit used by the interviewer.

Of greater practical relevance for some surveys than the size of the household is its composition and especially the number of children it includes. The Census gives, for each of the three towns, the proportion of private households with 0, 1, 2 . . . persons under the age of 16. In this case, the difference in the basis of the Census and the sample figures is clearly not as serious as in comparing size distributions. Table 17 gives the results for all towns combined, there being little variation between them. The problem of weighting for unequal household probabilities

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

again arises here; it so happens that the weighted and unweighted results differ little and, to save space, we only give the former.

TABLE 17

Distribution of households by Number of Persons in Household Under 16. *Census and Samples* (*Percentages*)

Number of Persons Under 16	*Census*	*Random Samples*	*Quota Samples*			
			*I*a	*I*b	*II*a	*II*b
0 . . .	56·6	59·7	60·7	58·0	57·0	58·0
1 . . .	20·4	21·4	20·8	22·2	20·2	21·4
2 . . .	14·0	11·5	12·1	12·6	15·0	12·2
3–4 . . .	7·6	6·2	5·6	6·3	5·8	7·7
5 + . . .	1·3	1·2	0·8	0·9	2·0	0·7
Total . . .	99·9	100·0	100·0	100·0	100·0	100·0

The distributions for all the samples are very close to the Census figures, those for the industrially-controlled quota samples remarkably so.

Standard errors.—So far, little emphasis has been placed on the magnitude of sampling errors for either the random or quota samples. In the tables above, we have been more interested in distributions than in individual comparisons. For the remaining questions (apart from one or two like income, where we are also mainly interested in distributions) we shall give estimates of the sampling errors for both the random and quota results.

In view of the theoretical argument usually, and justifiably, advanced against quota sampling, it may seem rather startling that we propose to calculate the sampling error for the quota samples here. This is possible only because, for this very purpose, our design was replicated. There were 24 basic cells in the quota samples (4 organizations, 3 towns, 2 control levels). Within each of these, there were two replicate samples of the same size and quota composition, selected and interviewed by two different interviewers. The variances for quota samples are computed from the sums of squares of differences between replicates, with divisors appropriate to the number of observations involved. In other words, they are derived from the difference in observed proportions between interviewers working under similar experimental conditions, i.e., on the same assignment scheme, control level, organization and town. In terms of section 3.3 below, the variance of quota samples is the residual mean square in the analysis of variance (except that the latter is in terms of transformed values).

The variances for the random samples* are calculated from the usual formula for the sampling variance of a proportion or mean. It is clear that the quota sampling variances contain a between-interviewer component which is excluded from the random variances. There was no replication in the random samples, so that this component could not be estimated. The interpretation of differences between the estimates of random and quota sample variances is discussed in section 3.2 below.

In the present section, standard errors rather than variances will be quoted, and each set of answers will be accompanied by three different standard error figures: that for the mean of the random sample (R), that for the overall mean of the quota sample (Q) and twice the standard error for the difference between the random and quota proportion or mean ($2(D)$). The third figure enables one to see at a glance whether the observed difference between the random sample and any of the four parts of the quota samples is significant at the 5 per cent. level. It follows from what has been said above that this figure, which is derived from the sum of the random and quota variances, is inflated by the between-interviewer component in the latter.

Where sample results are given for the three towns combined, the standard error is derived from the usual formula for stratified sampling.

We turn now to the group of four questions on which check data other than Census results are available. These are "Do you hold a ticket in your own name for the public library?", "Have

* They apply to the unweighted random results. It seemed more appropriate to give these rather than the standard errors for the weighted results, since it would be the former which would be calculated in practice. In any case, the difference between them would generally be small.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

any of you (referring to the household) a motor car?" "Do you have a television set?" and "Have you a telephone?"

There are serious difficulties of definition, area covered and date, all of which limit the usefulness of the available figures as checks. The comparisons should not be regarded as exact ones.

Library membership.—The results on the library question are shown in Table 18.

TABLE 18

Percentage of Persons Holding Tickets in the Public Library

Town	Random Samples		Quota Samples				Standard Errors		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Birmingham	18·1	19·7	23·9	24·7	16·9	24·6	2·3	3·9	9·2
Bristol	22·3	22·3	33·6	25·1	25·7	30·6	2·8	4·7	10·6
Edinburgh	38·1	38·4	40·1	27·6	36·3	35·4	3·1	4·6	11·0

The difficulty with the figures supplied by the Public Libraries is that they refer to the adult population aged 16 and over, while our results cover only those aged 20 and over. In Birmingham, the proportion of the population aged 16 and above holding library tickets is 18 per cent. The proportion for the population aged 20 and over would be slightly lower than this and the quota figures—except those for the industrially-controlled samples—are probably too high. The Bristol figure for the adult population is 23 per cent. and we would draw the same conclusion, certainly for the quota samples I*a* and II*b*. For Edinburgh it is not possible to obtain a comparable figure. The higher library figures for the quota samples may be due to the educational bias noted above.

*Ownership of cars, television sets and telephones**.—The results for the motor-car question are:

TABLE 19

Percentage of Households with Motor Cars

Town	Random Samples	Quota Samples				Standard Errors		
		*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Birmingham	12·3	14·3	15·0	15·3	16·6	2·1	2·0	5·8
Bristol	15·1	15·2	14·8	14·5	22·7	2·2	4·6	10·2
Edinburgh	8·5	9·2	9·4	11·4	8·1	1·8	1·9	5·2

Figures supplied by the Licensing authorities show that in the autumn of 1952 (that is, a few months after the experiment) the numbers of private motor cars owned and licensed in Birmingham, Bristol and Edinburgh were approximately 57,300, 25,200 and 17,600. Expressing these figures as proportions of the numbers of households, we find that about 17 per cent., 18 per cent. and 12 per cent. of the households in the three towns owned (and had licensed) a private car. These percentages do not allow for the possibility of more than one car per household.

The differences between the three towns are reflected in the sample results, but nearly all the proportions are below the check figures; it is striking how consistent most of the sample figures are.

Next, we compare our results on television ownership with estimates made by the B.B.C. from G.P.O. licence statistics.

TABLE 20

Percentage of Households with a T.V. Set

	Random Samples	Quota Samples				Standard Errors		
		*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Birmingham	23·5	16·8	22·9	24·8	20·5	2·6	2·4	7·2
Bristol	1·4	3·5	3·8	3·8	3·7	·8	1·3	3·1
Edinburgh	2·0	2·7	2·6	2·6	1·4	·9	1·1	2·9

* As these are household questions, the results have been re-weighted as for Tables 16B and 17. The age/sex weighting for the random samples has not been carried out.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The B.B.C.'s estimates for the date of the survey are 25·4 per cent., 3·4 per cent. and 2·3 per cent. for the three towns respectively. The sample results for Birmingham are all low, the closest being the industrially-controlled samples. The random figure for Bristol is well under the B.B.C. estimate but, apart from this, the results for Bristol and Edinburgh are close to the check data.

Finally, we have the figures of telephone ownership.

TABLE 21

Percentage of Households with a Telephone

	Random Samples	*Quota Samples*				*Standard Errors*		
		*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Birmingham . . .	11·2	13·0	17·5	8·0	16·7	1·9	3·1	7·3
Bristol	16·3	19·7	17·2	12·6	27·0	2·2	3·9	8·9
Edinburgh . . .	26·7	22·5	19·1	27·8	21·1	2·8	2·9	8·0

Figures estimated from Post Office data suggest that 9 per cent., 16 per cent. and 18 per cent. of households in the towns have residential telephones, but these estimates must be regarded as very approximate. Nearly all the sample results are higher than these, many considerably so. The question asked in our questionnaire could unfortunately be misunderstood in that it did not specifically mention *private* telephones. This may account for the high figures.

Work and Income

The answers to the remaining questions cannot be checked against population data for the three towns. We begin with those bearing on work and income.

TABLE 22

Percentage of Persons with a Paid Job

Random Samples		*Quota Samples*				*Standard Errors*		
(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
60·1	62·1	61·2	70·8	62·0	59·2	1·9	2·7	6·6

The random and quota samples do not differ significantly in the proportions of people with paid jobs that they include, with the exception of the interrelated samples which have a considerably higher percentage than any of the others. Of the people with paid jobs, about 90 per cent. work full-time (that is 30 hours a week or more) and again the samples differ little, as is shown by Table 23.

TABLE 23

Percentage of Persons with Jobs Working Full-time

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Percentage . .	87·1	80·3	87·0	91·1	89·8	87·6	1·7	1·2	4·2
*N** . . .	472		643	725	669	603			

* *N* = Sample numbers.

The interrelating of quotas not only results in a higher proportion of people with paid jobs but also, within this group, in more full-time workers. This difference between the *Ia* and *Ib* samples is virtually constant through the three towns.

Respondents with a paid job were asked on how many days a week they were at their job. The averages for the various samples varied little from 5½ days and it is not worth quoting the results. The three next questions referred to the journey to work. It might be expected that,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

because of the way quota sampling works, this would be a subject on which there would be substantial differences between the sample results. Tables 24, 25 and 26 give the results for the time taken to get to work, the form of transport used and the average weekly amount spent on public transport.

TABLE 24

Average Time (in Minutes) Taken to Get to Work (Persons with Full-time Job only)

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Minutes	27·7	24·2	26·3	25·6	23·6	25·7	1·1	1·0	2·9
N	417		556	660	595	526			

TABLE 25

Form of Transport Used to Get to Work (All Persons with Paid Jobs)
(Percentages)

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Foot	25·2	30·4	26·9	20·2	27·5	26·1	2·0	2·0	5·8
Bicycle	10·9	7·3	10·5	9·6	11·6	8·7	1·4	1·8	4·6
Motorcycle	1·3	1·1	1·4	2·2	4·3	2·1	·5	·6	1·6
Car	8·5	5·9	5·2	6·0	6·9	8·8	1·3	1·0	3·3
Public Transport	54·1	55·3	56·0	61·9	49·7	54·4	2·4	2·7	7·3
Total	100·0	100·0	100·0	99·9	100·0	100·1			
N	472		643	725	669	603			

TABLE 26

Average Amount Spent per Week by those Using Public Transport
(Shillings)

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Sh.	3/10	3/9	4/2	3/8	4/1	4/3	–/2	–/2	–/6
*N**	252		332	378	321	292			

Whatever else these tables may show, they do not suggest any basic difference in the journey-to-work habits of quota and random respondents. The only aspect on which differences are at all sizeable is that of form of transport used. It is not surprising, perhaps, that quota samples, which rely heavily on street interviews, include fewer car travellers than the random samples which are based entirely on home interviews. On the other hand, one might have expected the same to hold of motor-cyclists and cyclists, but our results show no differences.

Women respondents were asked whether they were housewives—in the sense that they were "the persons mainly responsible for domestic duties in their household":

TABLE 27

Percentage of Women who are Housewives

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Percentage	82·1	81·8	84·0	74·4	86·7	84·5	2·0	2·2	6·0
N	446		580	589	586	586			

* For a variety of reasons (particularly the fact that answers recorded as "Not applicable" or "Don't know" were excluded before the percentages in Table 25 were computed) the "*N*'s" in Table 26 do not exactly correspond to those expected from the figures in Table 25.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The only figure calling for comment is the low percentage obtained by the interrelated quota samples. Here, as in several other instances, the interrelated samples differ markedly from all the others, quota and random.

Finally in this section, we have the income distributions for the various samples.

TABLE 28

Distribution of Persons by Income Last Week.* (*Percentages*)

Males

Income	*Random Samples*		*Quota Samples*			
	(a)	(b)	*I*a	*I*b	*II*a	*II*b
None	—	—	·8	·2	·5	·3
Less than £3	11·1	7·7	12·9	8·2	12·0	11·0
£3–£5	6·6	8·0	6·9	9·5	8·3	7·2
£5–£7 10*s.*	36·5	37·3	40·3	42·8	45·6	41·2
£7 10*s.*–£10	29·2	29·4	23·0	25·7	22·0	26·5
£10–£20	14·7	16·0	12·7	10·7	10·8	12·0
More than £20	1·8	1·7	3·3	3·0	·8	1·8
Total	99·9	100·1	99·9	100·1	100·0	100·0

Females

Income	*Random Samples*		*Quota Samples*			
	(a)	(b)	*I*a	*I*b	*II*a	*II*b
None	28·1	28·1	23·8	24·3	30·9	24·9
Less than £3	46·5	45·6	39·5	32·9	37·4	46·5
£3–£5	16·4	16·8	21·6	27·2	24·6	18·4
£5–£7 10*s.*	6·4	6·0	11·7	11·0	5·3	7·8
£7 10*s.*–£10	1·8	2·9	2·4	2·8	1·2	1·5
£10–£20	·7	·6	·7	1·6	·4	·8
More than £20	—	—	·3	·2	·2	·1
Total	99·9	100·0	100·0	100·0	100·0	100·0

* The definitions used are shown in the questionnaire in Appendix A.

In view of the educational and occupational bias noticed earlier, one might have expected the quota samples to under-represent the lower income ranges (although the connection is complicated by other factors, notably age). The results, especially for males, point in the opposite direction. The male distributions show little difference for the "less than £3" group or for the upper end of the scale. The real difference lies in the middle ranges; the random figure is well below the quota for the "£5–£7 10*s.*" group and well above it for that of "£7 10*s.*–£10". The same difference was shown in the national comparison in Table 2 above; we hope, by further analysis, to find an explanation of this difference.

For females, the figures in the bottom two groups are lower for quota than for random, but these are affected by the varying proportions of housewives (and of mothers receiving family allowances).

It may be worth recording that the proportion of persons who refused to answer the income question or answered "Don't know", was approximately 4 per cent. for the quota and 2 per cent. for the random samples.

Living accommodation.—The next three tables show whether the respondents live at home, as lodgers or boarders with a family, in a hotel or hostel or boarding-house or some kind of institution; if they live at home, in what kind of house or flat; and, if a house, whether they own or rent it.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 29

Distribution of Persons by Where Living. (Percentages)

Living	*Random Samples*		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*	R	Q	2(D)
At home	94·9	96·0	91·1	92·2	94·5	90·4	·9	1·8	4·0
As lodger, etc.	2·6	2·4	6·2	4·4	3·8	5·0	·7	1·1	2·5
Hotel, hostel, etc.	1·7	1·4	·8	2·3	1·0	1·5	·5	·9	2·0
Elsewhere	·8	·2	1·9	1·1	·7	3·1	—	—	—
Total	100·0	100·0	100·0	100·0	100·0	100·0			

The trend of the figures shows—although the differences are not generally statistically significant—that the quota samples (except for those with an industrial control) have fewer people living at home and rather more in the boarder and lodger category than the random samples. Unfortunately, these figures cannot be reliably checked. The proportion living in flats hardly varies

TABLE 30

Distribution of Those Living at Home by Type of House. (Percentages)

Type of House	*Random Samples*		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*	R	Q	2(D)
Whole detached	4·8	4·6	11·2	9·6	7·2	8·2	·9	1·2	2·9
Whole S/D	33·3	32·4	28·5	29·6	23·7	32·8	1·9	3·0	7·0
Whole terrace house	32·7	31·2	30·6	31·1	38·8	26·1	1·8	2·6	6·9
Self-contained flat	23·1	25·8	22·4	23·1	22·1	28·1	1·2	1·5	3·8
Other	6·1	6·0	7·3	6·6	8·2	4·8			
Total	100·0	100·0	100·0	100·0	100·0	100·0			
N	767		988	1,002	1,015	949			

between samples—with the exception of the II*b* quota samples. What is notable is the significantly higher percentages in the quota samples of persons living in whole detached houses. It is hard to think of any *a priori* reason why the randomly selected individuals should, on average, have fewer detached houses than those in the quota samples. Yet, in the random sample only 7 per cent. of all the houses are detached, while for the four parts of the quota samples the percentages are 16 per cent., 14 per cent., 10 per cent. and 12 per cent. There are three possible explanations. First, as we have had occasion to notice above, there may be a bias in the quota samples against the "lower" social class groups. Secondly, the random sample interviewer is able to check the information on type of house by observation; the quota sample interviewer, when working in street or office, cannot do so. Inaccuracy of description, together perhaps with the snob-value connected with detached houses, may have helped to drive up the quota sample percentages. Thirdly, the random figure may be too low as a result of non-response bias.

The next table gives some information about ownership of houses. The differences between samples are small.

TABLE 31

Percentage of Those Living at Home Owning Their Houses

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*Ia*	*Ib*	*IIa*	*IIb*	R	Q	2(D)
Percentage owning	36·7	38·7	37·6	38·7	33·0	35·7	2·4	3·6	8·6
N	496		648	641	623	567			

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

• *Cinema-going, football pools, smoking and newspaper reading.*—Finally, we have four questions relating to leisure. Doubts have sometimes been expressed whether quota sampling is suitable for a subject like cinema-going because of a possible tendency to get too many film-goers. The results support this view.

TABLE 32

Distribution of Persons by Occasion of Last Visit to Cinema. (*Percentages*)

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Within last 7 days . .	23·9	26·2	29·7	29·8	28·3	29·5	1·6	2·2	5·5
8–14 days ago . . .	7·3	7·7	9·0	8·2	10·8	9·9	1·0	1·8	4·2
15–28 days ago . .	9·3	9·9	9·4	8·3	9·7	9·2	1·2	1·2	3·4
More than 28 days ago .	42·3	40·8	32·7	34·5	27·8	35·8	1·9	3·8	8·6
I never go . . .	16·5	14·6	17·9	17·9	18·6	14·1	1·4	3·1	6·8
D.K.	·7	·8	1·3	1·3	4·8	1·5			
Total . . .	100·0	100·0	100·0	100·0	100·0	100·0			

The quota samples contain a much lower percentage of what might be called "occasional" cinema-goers (last visit more than 28 days ago), and a significantly higher proportion of persons having been within the 7 days before interview. It does not follow necessarily that it is the quota samples that are biased. It may be true that they tend to get too many film-goers but it may also be that the frequent film-goers are the kind of people missed by random samples. It has sometimes been noticed that, on "activity" questions—such as cinema-going, reading, smoking—quota samples tend to get higher percentages (taking part) than random samples. This might well be the effect, not only of differences in social composition of the samples, but also of a tendency of random samples, through non-response, to miss the more "active" people.

Respondents were asked whether they did football pools last season. The results are given below.

TABLE 33

Distribution of Persons by Whether they did Football Pools Last Season. (*Percentages*)

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Yes (alone) . . .	23·9	23·8	29·4	22·8	27·2	28·2	1·7	2·1	5·3
Yes (shared) . . .	17·9	19·1	13·7	16·4	16·5	14·0	1·4	2·3	5·5
No	58·2	57·1	56·9	60·8	56·3	57·8	1·9	1·9	5·4
Total . . .	100·0	100·0	100·0	100·0	100·0	100·0			

There is little difference in the proportion who did not do pools at all. Curiously, the random samples have a lower proportion of people doing the pools alone and a higher proportion using shared coupons. This may be a reflection of the different industrial or social composition of the quota and random samples.

The quota samples seem to have slightly more smokers, as is shown in the next table, though the differences fall far short of statistical significance. Those who said they smoked were further asked how many cigarettes they smoked yesterday. The averages are shown below; again the difference between quota samples and random samples is in the same direction, namely, the former are higher.

Finally, Table 35 shows the percentage of informants reading particular national daily and Sunday newspapers.

Differences between the samples are relatively slight. As was found in an unpublished comparison made for the 1952 Hulton readership surveys, the quota samples show a lower "None read" percentage than the random samples. This could be due to random non-response bias or to the educational bias in the quota samples. There are other indications in the table of social

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

TABLE 34

Percentage of Persons who are Smokers and Their Average Number of Cigarettes Smoked Yesterday

	Random Samples		*Quota Samples*				*Standard Errors*		
	(a)	(b)	*I*a	*I*b	*II*a	*II*b	R	Q	2(D)
Percentage smoking	52·3	53·2	53·5	55·7	54·5	56·2	1·9	1·9	5·4
Average number of cigarettes smoked yesterday	10·5	9·4	11·5	11·5	11·7	12·0	·4	·4	1·1
N (for last row)	426		567	593	587	601			

TABLE 35

Percentage of Persons Reading Stated Daily and Sunday Newspapers

	Random Samples		*Quota Samples*			
	(a)	(b)	*I*a	*I*b	*II*a	*II*b
Daily Papers						
Daily Mirror	33·5	34·2	32·1	34·2	33·3	29·0
Daily Graphic	4·2	4·2	4·4	5·9	4·2	3·5
Daily Express	22·8	23·5	30·5	29·9	27·1	28·1
Daily Mail	13·9	13·6	17·8	16·3	18·0	15·1
Daily Herald	10·1	9·8	9·1	9·7	9·6	8·1
News Chronicle	4·5	4·3	6·0	3·9	5·1	4·3
Daily Telegraph	3·2	3·3	3·8	3·3	2·5	4·0
Manchester Guardian	·2	·2	·9	·8	·1	·7
The Times	·5	·5	1·6	1·3	1·0	1·2
Daily Worker	·5	·5	1·5	·9	·3	·7
None of these	26·8	26·7	19·1	22·2	22·1	26·4
Sunday Papers						
News of the World	43·9	43·2	41·8	43·6	39·8	42·4
The People	29·1	28·6	29·0	32·4	30·3	28·8
Sunday Express	17·0	17·3	20·6	22·5	23·8	21·3
Sunday Graphic	5·3	5·6	6·0	6·0	6·3	4·6
Sunday Pictorial	31·7	34·2	30·1	32·2	34·7	28·1
Sunday Chronicle	2·9	3·0	3·2	5·0	6·1	3·1
Sunday Dispatch	13·5	14·6	14·3	17·1	14·2	13·6
Reynolds News	3·1	3·0	4·3	3·9	3·5	4·3
Empire News	5·2	6·5	4·9	6·4	5·7	2·9
Observer	3·3	3·2	5·0	4·6	2·4	3·1
Sunday Times	1·6	1·5	3·1	3·1	2·6	2·1
None of these	18·9	18·1	15·2	13·6	13·2	16·7

or educational differences, although some of the figures are too small to allow generalization. The quota proportions are higher for papers like *The Times*, the *Manchester Guardian*, the *Daily Telegraph*—all papers read mainly by the "higher" social classes.

This concludes our presentation of the random and quota sample results. On some questions, there is evidence of bias in the quota samples; on others, they agree closely with check data or random sample results. Although it is not easy to discern consistent trends in the results, we offer some tentative conclusions in the final part of this paper.

3.2. *The Variability of Quota Samples*

The estimates of random and quota sampling variances given in section 3.1 may be compared, to give us some idea of the relative variability of the two methods. We emphasize again that, while the random sampling variances are theoretical estimates based on standard formulae, the estimates of quota sampling variances are based on differences between replicates within the different factor-combinations of our experiment. In other words, the quota sampling variances

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

are estimates of the total inherent variability of the quota sampling process, including between-interviewer variability. The random sampling variance, on the other hand, take no account of between-interviewer variation: indeed, they could not do so, as the random samples were not replicated. It is generally to be expected, of course, that the "interviewer component" of sampling variance is much larger for quota than for random sampling, for the quota sampling process is subject to all the sources of variation involved in random sampling, with the respondent-selection source superimposed.

In Table 36, we show, for all the main questions, the estimated quota sampling variance expressed as a percentage of the random sampling variance for that question. The quota sample estimates are based on samples of 360, and the average random sample size was about 270, so the ratio of variances has a factor of $\frac{4}{3}$ in favour of quota sampling; this has been corrected in the table, which is thus on the basis of equivalent sample size.

TABLE 36

Ratios of Quota and Random Sampling Variances and of Coefficients of Variation

	*Question and Variable**	$\frac{\text{Quota Variance}}{\text{Random Variance}}$ %	$\left(\frac{\text{Quota Coeff. of Variation}}{\text{Random Coeff. of Variation}}\right)^2$ %
2.	Percentage housewives	165	160
3.	(*a*) Percentage with paid jobs	266	243
4.	Percentage with full-time jobs	72	64
5.	Average number of days per week at job	197	362
6.	Average time to get to work	121	232
7.	(*a*) Percentage by public transport	171	160
7.	(*b*) Average amount spent on public transport	194	400
8.	(*a*) Percentage who went to pictures within last 7 days	246	168
8.	(*b*) Average number of times during last 7 days	217	406
9.	Percentage did not go in for football pools	131	135
10.	(*a*) Percentage who smoke	125	126
10.	(*b*) Average number of cigarettes smoked yesterday	92	168
11.	Percentage holding ticket in public library	368	293
12.	(i) Percentage read no daily morning papers yesterday	284	406
	(ii) Percentage read *Daily Mirror* yesterday	174	188
13.	(i) Percentage read no Sunday paper last Sunday	180	298
	(ii) Percentage read *News of the World* last Sunday	332	356
14.	Percentage married	177	201
15.	Percentage living at home	576	568
16.	(*a*) Percentage living in flats	223	195
	(*b*) Percentage owning house	291	308
17.	(i) Percentage households with no children 0–4	288	296
	(ii) Average size of household	259	247
	(iii) Percentage 1-person households	450	174
18.	Percentage with motor car	182	125
19.	Percentage with T.V.	115	127
20.	Percentage with telephone	293	276
21.	Percentage finishing education at 15 and over	176	116
22.	Percentage with more than £7 10*s.* per week	90	122

* For more detailed description of "variable", refer to questionnaire in Appendix A.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The last column of the table, which shows the ratio of the squared coefficients of variation* of the two methods, gives the ratio of the *proportional* variabilities of the two methods.

It will be seen that, as a general rule, the values vary between 100 and 300 per cent., with one or two exceptional values falling outside this range. If one considers proportional variability rather than absolute variability, as in the second column of the table, one finds a marked increase in disparity in a few cases, but little change in the overall picture.

These figures must be interpreted with care. They do not give a comparison of the pure sampling variances of the two methods, for the quota estimate contains the additional component of between-interviewer variation. Such a comparison is not indeed possible here because, on the one hand, the between-interviewer variability cannot be estimated for the random samples in the absence of replication while, on the other, it is not possible to isolate the within-interviewer sampling variance for the quota samples. The stratification imposed by the quota controls makes it probable that this within-interviewer variance does not exceed the corresponding variance of random sampling. It is reasonable to suppose, therefore, that the differences between the quota and random variances, shown in Table 36, are mainly due to between-interviewer variability. This itself is made up of two distinct factors. On the one hand, there is the selection factor: interviewers, subject to exactly the same constraints imposed by the experiment and the quotas, select samples which differ in their average characteristics. On the other hand, there is the interviewing factor: interviewers ask questions in different ways, interpret and code answers differently and so forth. The distinction between the two contributory sources of variability among interviewers is important because the selection factor does not enter into random sampling at all, while the interviewing factor does. This experiment does not make any evaluation of the magnitude of the two sources possible, but it seems to us beyond question that the greater part of between-interviewer variability found in this experiment is due to selection differences. If our questions were concerned with opinions, we would be more hesitant in drawing this conclusion; even for behavioural questions, one might expect the interviewing factor to make a substantial contribution. But Table 36 shows that, even on the straightforward factual questions—such as marital status, household composition and size, telephone ownership and several others—the quota sampling variability is well in excess of the estimate of random sampling variance. This is a clear indication that selection differences between interviewers working on the same assignments and within the same experimental cells are the main cause of the high quota sampling variability.

3.3. *Differences between Towns, Organizations, Control Levels and Assignment Schemes*

In section 3.1 we gave the results of the random and quota samples distinguishing among the latter the samples using only the basic controls (on independent or interrelated assignments) and those using an additional control (industrial or geographical). As we saw, the differences between these types of quota samples were slight on some questions, substantial on others, and it was difficult to discern a systematic pattern running through the results. Nevertheless, when looked at question by question, the figures suggested certain tentative conclusions about the value of additional controls and of interrelating the quotas.

It is not satisfactory to base one's conclusions on general impressions alone, valuable though they are, and the design of the experiment does enable us to test the significance of the various effects. In presenting the results of these tests, we should like to stress our view that, in an experiment such as this, the assessment of statistical as opposed to practical significance should not be regarded as the only or even the main objective. In addition, it should be borne in mind throughout this section that the finding of statistical significance itself depends not only on the strength of the factor-effect but also on the size and sensitivity of the experiment. We return to this point later.

The question we attempt to answer in this section is, to what extent are the observed differences between organizations, control levels and assignment schemes statistically significant? In comparing the results of the tests with the tables in section 3.1 it should be noted that those tables referred mostly to the three towns and four organizations combined, while the tests below are made on the individual observations.

* Squaring was necessary to preserve dimensional comparability with the previous column.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The design of the experiment was explained in Part I and there is no need to discuss further the type of factorial lay-out we have used, the assumptions underlying it or its advantages. Readers are referred to one of the texts on experimental design (such as that by Cochran and Cox (2)), and, for an example of the use of a similar design in a previous experiment of the Division, to a paper by Durbin and Stuart (3).

The three main factors in the experiment are towns (Birmingham, Bristol and Edinburgh), organizations (1, 2, 3 and 4) and control levels (I and II). Each organization carried out two independent quota samples of 90 interviews at each control level in each town, making a total of 48 samples. The following analysis is conducted, question by question, on the proportions or means for these 48 samples. For example, in Q.3(*a*) of our questionnaire, each respondent is asked whether he has a paid job or not. He answers "Yes" or "No". Our analysis is carried out, not on these individual answers, but on the proportion of "Yes" answers obtained on each sample of 90. The straightforward analysis of variance for any question would be:

Analysis of Variance A

Source of Variation	*Degrees of Freedom*
Towns	2
Organizations	3
Control Levels	1
Town/Organization interaction	6
Town/Control Level interaction	2
Organization/Control Level interaction	3
Town/Organization/Control Level interaction	6
Residual	24
Total	47

This analysis is, however, unsatisfactory for comparisons between control levels. It will be recalled that, at control level II, two of the organizations used an additional industrial control (II*a*) and two an additional geographical control (II*b*). The two controls are quite different in character and there was some evidence that they tended to affect the results in opposite directions. The above analysis of variance contrasts control level I with the *average* control level II and this may clearly be misleading. We have, therefore, preferred to divide the observations into two halves of 24, those for organizations 1 and 2 (which used II*a*) and those for organizations 3 and 4 (which used II*b*). The analysis of variance for either half is:

Analysis of Variance B *and* C

Source of Variation	*d.f.*
Towns	2
Organizations	1
Control Levels	1
Town/Organization	2
Town/Control Level	2
Organization/Control Level	1
Town/Organization/Control Level	2
Residual	12
Total	23

Several comments should be made on the use of the analysis of variance. First, one of the assumptions underlying the significance tests following on such an analysis is that the observations in the different cells come from populations with equal variances. In the case of proportions, this assumption does not hold as the variance is not independent of the mean. In order to stabilize the variance, the angular transformation is usually recommended (see, for example, Bartlett (4) or Quenouille (5)) and this was employed here on the attribute questions. On these, the analysis was therefore not performed on the observed proportions p, but on the transformed values

$$y = \text{arc sin } \sqrt{p}$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Secondly, one needs to be clear about the type of model underlying the experiment, that is whether the levels of the different factors are to be regarded as fixed constants or as random variables. For example, is the factor "organization" to be regarded as a random variable in the sense that the four organizations included in the experiment are a random sample from a population of organizations? The question is a basic one for any experiment, since it affects the

TABLE 37

Summary of Significance Test Results on Effects and Interactions, Question by Question

Question Number and Answer Tested†	*Organizations 1 and 2*						*Organizations 3 and 4*					
	Towns	*Organizations*	*Control Levels*	*T./O.*	*T./C.L.*	*O./C.L.*	*Towns*	*Organizations*	*Control Levels*	*T./O.*	*T./C.L.*	*O./C.L.*
2. Percentage housewives	..	..	..	..	*	..	..	..	..	..	*	..
3. (*a*) Percentage with paid jobs	..	..	..	..	*	..	..	..	..	..	..	..
3. (*b*) (i) *Occupation* Percentage operatives	..	..	..	..	..	..	..	*	..	..	..	..
(ii) *Industry* Percentage manufacturing	**	..	**	..	..	..	*	..	..	..	..	..
(iii) Percentage distribution	**	**	*	..	..	*	..	..	..	..	..	..
4. Percentage with full-time jobs	..	..	..	..	..	..	..	..	..	..	..	..
5. Average number of days at job	**	..	..	..	..	..	..	*	..	..	..	..
6. Average time taken to get to work	*	..	..	..	..	..	*	..	..	..	..	..
7. (*a*) Percentage by public transport	*	..	..	..	**	..	**	..	..	..	..	..
7. (*b*) Average amount spent on public transport	..	..	..	..	..	..	..	*	..	..	..	..
8. (*a*) Percentage who went to pictures within last 7 days	**	..	..	..	..	..	..	..	..	..	..	..
8. (*b*) Average number of times during last 7 days	..	..	..	..	..	..	*	..	..	..	..	..
9. Percentage did not go in for football pools	..	..	..	..	..	*	*	..	..	..	..	..
10. (*a*) Percentage who smoke	..	..	..	..	..	..	..	..	..	..	*	..
10. (*b*) Average number of cigarettes smoked yesterday	..	..	..	..	..	..	..	..	..	..	..	..
11. Percentage holding ticket in public library	*	..	..	..	..	..	*	*	..	..	..	..
12. (i) Percentage read no daily morning papers yesterday	*	..	..	..	..	..	**	*	..	..	..	..
(ii) Percentage read *Daily Mirror* yesterday	**	..	..	..	..	..	**	*	..	..	..	..
13. (i) Percentage read no Sunday paper last Sunday	**	..	..	..	..	..	**	..	..	..	..	..
(ii) Percentage read *News of the World* last Sunday	..	..	..	..	..	..	*	..	..	..	..	..
14. Percentage married	**	..	..	..	**	..	..	..	..	..	..	..
15. Percentage living at home	..	..	..	..	..	..	..	*	..	..	..	..
16. (*a*) Percentage living in flats	**	..	..	..	*	..	**	..	**	..	..	..
16. (*b*) Percentage owning house	*	..	..	..	..	..	**	..	..	..	..	..
17. (i) Percentage with no children 0–4	..	..	..	..	*	..	..	..	..	..	*	..
(ii) Average size of household	..	..	..	..	..	..	..	*	..	..	..	..
(iii) Percentage of 1-person households	..	..	..	..	*	..	..	*	..	..	..	..
18. Percentage with motor car	*	**	..	..	..	..	*	*	..	..	..	..
19. Percentage with T.V. set	**	..	..	..	..	*	**	*	..	..	..	..
20. Percentage with telephone	*	..	..	..	*	..	..	**	..	..	..	..
21. Percentage finishing education at 15 and over	**	..	**	..	..	..	..	**	..	..	..	..
22. Percentage with more than £7 10*s.* income	**	..	*	..	*	..	*	..	..	*	..	..

* Denotes significance at 5 per cent. level.
** „ „ „ 1 per cent. level.
Otherwise not significant.
† See Appendix A.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

analysis and interpretation of the results. As regards this experiment, it is clear that the fixed constants model is the appropriate one. In the case of control levels, for instance, although one can conceive of any number of possible levels, the two in our experiment (or three if II*a* and II*b* are distinguished) were purposively selected and constructed; there is no justification for regarding them as values of random variables and drawing inferences from them to a wider population. The same argument applies to the other factors.

Thirdly, several of the questions in the questionnaire had more than two possible answers. In these cases we had to decide on which answer or answers to do the analysis. We avoided the answers applying only to small numbers and chose those which seemed of greatest interest. We omitted from our analysis three questions (20(*b*) and those parts of questions 12 and 13 referring to local papers) for which the numbers were very small.

To save space, we do not reproduce the actual analysis of variance results* but summarize the significance or otherwise of the effects in Table 37. The left-hand half refers to the organizations with the additional industrial control, the right-hand half to the other 24 observations.

The striking feature of this table is the relatively small number of significant effects. The only factor which shows many significant differences is that of towns; little interest attaches to this since the towns in this experiment played much the same part as blocks in an agricultural experiment. It is puzzling that there should on any question be significant town differences in one-half of the table and not in the other. Yet there are nine questions on which this is the case. In six of these, it is the left half of the table, that with the industrial control, that produces the significant town differences and all but one of these are at the 1 per cent. level. It seemed possible, therefore, that the industrial control was having an effect in bringing out the real town differences. Whether this was, in fact, happening could only be tested on two or three questions on which we had check data; for these, the explanation did not hold. Table 38, which shows the percentages of persons in the Distributive Trades, is an example. The check data are those derived from Ministry of Labour figures.

TABLE 38

Percentage of Persons in Distributive Trades. Check Data and Quota Samples

Towns	*Organizations 1 and 2*				*Organizations 3 and 4*		
	Check Data	*C.L. I*	*C.L. II*	*Average*	*C.L. I*	*C.L. II*	*Average*
Birmingham	5·9	7·5	6·1	6·8	9·0	15·4	12·2
Bristol	7·0	20·2	9·6	14·9	8·2	9·4	8·8
Edinburgh	8·3	14·9	8·3	11·6	15·9	10·2	13·0

The industrial control has indeed, as is to be expected, corrected the tendency of the Control-Level I samples to over-represent distributive workers. It cannot, however, be said to be responsible for "bringing out" the difference between towns.

Regarding differences between organizations, the most notable fact about Table 37 is that organizations 1 and 2 do not appear to differ from each other, while organizations 3 and 4 do so on a large number of questions. Table 37 gives 32 comparisons made on 26 separate questions. Even allowing for the fact that these 26 questions, coming as they do from the same questionnaire, cannot be considered as independent, one would not (on the 5 per cent. level) expect as many as 11 of the questions to be significant by chance. Organizations 3 and 4 differ particularly on the "classification" questions at the end of the questionnaire—ownership of cars, television sets, telephones and education. This suggests a difference in the social composition of the samples from the two organizations, in spite of the fact that their social class quotas are virtually identical. It is worth noting that, on these four questions, the figures for organization 4 were higher than those of organization 3; in three of them (all but the television question) the difference was of the order of 50 per cent.

There are several possible explanations for these organizational differences. First, organization 4 had to do its part of the experiment some months after the other organizations and during the

* These are available on request.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

holiday period. In view of the particular questions involved, this is unlikely to be the chief explanation. Secondly, the differences could be due to the fact that one of the organizations used independent assignment schemes, the other interrelated quotas. The comparison of results for the different schemes, reported below, makes this an unlikely explanation. Thirdly, we recall that organization 4, unlike the other three, used for this experiment a type of assignment scheme other than that to which its interviewers are accustomed. Finally, one of the interviewers in organization 4 produced extreme results on many questions—notably those closely related to social class, such as the "classification" questions—and this accounts for some of the significant organizational differences. It should be stated that this interviewer was independently found by her organization to be doing unsatisfactory work on other surveys and was dismissed.

Neither differences between towns or organizations are, from our point of view, of primary interest. We are more concerned with differences between control levels and assignment schemes, since these represent variations in quota sampling practice. On both, our significance tests produce largely negative results. Let us look at control levels first. Table 37 shows that the geographical control has made no effective difference. On the industrial control, the evidence is more difficult to interpret. Apart from the industrial question itself, it has made a significant difference on the basic questions of education and income and we recall from section 3.1 that the industrially-controlled samples gave more accurate results on the education question than the other quota samples.

But it is clear from the left half of Table 37 that the effectiveness of the industrial control varies with town and organization. This is the meaning of the large number of significant interactions between control level and town or organization. The former is easier to understand, since one would expect the worthwhileness of setting an industrial control to depend on the type of town. Closer study of the figures leads to conflicting conclusions; it is by no means true to say that the industrially-controlled samples are always closer to the check figures than those not so controlled. But there is no doubt that this control does have a marked effect on several question results, that its effectiveness varies with town and organization and that, in some cases, it brings the results closer to the population values.

Finally, we can test the significance between assignment-schemes. For this purpose, we use the analysis of variance A, because in the others (B and C) there is only one d.f. for organizations, so that differences between assignment-schemes cannot be separated from those between organizations. In form A, there are 3 d.f. for organizations and one of these may be split off for the comparison of organizations 1 and 4 with organizations 2 and 3, which is a comparison of assignment-schemes. The relevant sum of squares is orthogonal to the other comparisons and may be tested in the usual way. The rest of the analysis of variance table changes, of course, because the interaction terms are altered, but it is perhaps unnecessary to reproduce the form of the analysis. Suffice it to say that the analysis was done on all the questions and that on only four of them was the between assignment-scheme effect significant. These were the questions on occupation, industry, whether the respondent had a paid job or not and one of the readership questions. We conclude that, as regards this experiment, the interrelating of quotas has not made an effective difference to most of the results. It is certainly surprising that the substantial differences in the composition of the independent and interrelated samples shown in section 2.2 have had so little apparent effect on the results. It also seems surprising that some of the considerable differences in results between interrelated and independent samples, which were shown in section 3.1, have not been found significant in the analysis of variance. But, as we go on to demonstrate in the next section, the lack of significant findings is connected with the insufficient sensitivity of the experiment and should not be taken to prove that in practice the interrelating of quotas, for instance, is not worth while.

3.4. *The Sensitivity of the Experiment*

So many of the contrasts in our analyses of variance proved to be non-significant that it is of importance to obtain estimates of the sensitivity of the tests to which the material was subjected. In particular, the contrasts between control levels and between assignment schemes, which have been discussed in section 3.3, require investigation from this point of view.

The question which we want to answer is: how large must the difference (between control levels or between assignment schemes) have been for any particular question, in order to have

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

had a reasonable chance of detection by our experiment? We can go some way towards answering this question by using the tables computed by Neyman and Tokarska (1936). These authors consider only one-sided alternative hypotheses at the 5 per cent. and 1 per cent. levels; we are equally interested in variations in either direction, for which their tables are equivalent to the use of 10 per cent. and 2 per cent. significance levels. We make use only of the latter.

Using this level of significance on the null hypothesis, and taking the residual variances in the analyses of variance to be the true variances in every case, we have used the tables to find the value of the difference (between control levels or between assignment schemes) which would have been necessary in order to give us a probability of one-half that the null hypothesis be rejected. The experiment would then be said to have a *power* of 50 per cent. We regard this as a minimum requirement in testing a null hypothesis—in practice, one might often require a power very much greater than 50 per cent. In Table 39, for each question analysed, and each of the three analyses carried out, three figures are given. The first is the observed difference (between control levels or between assignment schemes) as a percentage of the overall mean for the question in that analysis. Column 2 contains the observed difference (transformed where necessary) and column 3 the estimate of the (transformed) difference required for 50 per cent. power. It must be remembered,

TABLE 39

Analysis of the Power of the Tests (A) Between Assignment Schemes (Interrelated vs. *Independent); (B) Between Control Levels (Basic* vs. *Industrial); (C) Between Control Levels (Basic* vs. *Geographical)*

Key to column headings: (1) Observed difference as a percentage of overall mean.
(2) Observed difference (transformed where necessary).
(3) Absolute difference required for 50 per cent. power.

Question Number and Answer Tested†	*Analysis (A)*			*Analysis (B)*			*Analysis (C)*		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
2	10·6	1·7	5·1	27·2	2·6	6·6	12·4	1·7	8·5
3 (*a*)	13·8	3·4*	3·6	4·0	1·2	4·8	16·3	3·9	5·9
3 (*b*) (i)	17·3	3·9*	3·5	10·6	2·4	5·3	6·8	1·5	5·1
(ii)	12·1	1·7	5·4	49·2	7·6**	6·1	11·5	0·8	9·6
(iii)	42·6	3·9**	2·8	56·3	5·0*	3·6	5·5	0·4	4·7
4	18·4	1·6	3·6	10·3	0·9	4·2	4·3	0·1	6·5
5	2·0	0·05	0·1	1·2	0·11	0·2	0·9	0·1	0·2
6	2·9	0·8	2·6	4·6	0·7	3·8	3·2	1·1	4·0
7 (*a*)	6·4	1·9	3·2	4·2	1·2	4·7	8·8	2·6	4·9
7 (*b*)	4·4	0·4	0·6	10·1	0·2	0·9	9·5	0·4	0·9
8 (*a*)	4·4	0·7	3·3	1·0	0·3	4·0	5·9	1·0	5·8
8 (*b*)	3·1	0·1	0·1	6·5	0·04	0·2	5·2	0·1	0·3
9	4·0	1·3	2·6	8·7	2·8	4·2	1·3	0·4	3·6
10 (*a*)	4·8	1·2	2·0	5·1	1·4	2·7	4·0	1·0	3·3
10 (*b*)	2·6	0·2	1·1	2·6	0·3	1·4	1·7	0·3	1·8
11	15·9	2·5	4·3	9·4	2·3	6·3	0·3	0·1	6·5
12 (i)	20·2	2·9*	3·3	10·2	1·4	5·1	17·9	2·6	4·7
(ii)	8·2	0·9	2·1	5·6	0·1	3·3	5·3	0·6	3·0
13 (i)	8·4	0·5	2·6	5·5	0·2	4·4	23·5	2·4	3·4
(ii)	0·01	0·1	2·4	4·9	0·7	3·9	4·8	0·9	3·3
14	2·0	0·8	3·1	3·7	1·5	3·4	2·1	0·8	5·6
15	2·2	2·0	4·4	2·0	2·4	7·5	3·3	2·4	5·4
16 (*a*)	4·2	0·1	3·1	5·5	0·3	4·4	24·2	5·8**	4·8
16 (*b*)	2·1	0·6	6·3	14·4	4·1	10·2	2·4	0·6	8·6
17 (i)	1·3	0·7	2·9	2·9	1·9	4·3	2·0	1·2	4·5
(ii)	0·6	0·03	0·2	4·1	0·02	0·2	0·9	0·1	0·3
18	0·1	0·4	3·2	0·2	0·1	3·9	22·9	2·4	5·6
19	9·9	2·0	2·6	5·7	0·3	4·5	3·5	0·3	3·0
20	12·5	1·6	3·5	23·0	3·8	5·2	21·1	2·9	5·2
21	10·8	2·0	3·6	30·2	5·8**	4·8	4·6	1·0	5·8
22	1·2	2·1	2·3	23·8	2·9*	3·1	7·5	0·8	3·6

* Denotes significance at 5 per cent. level; ** denotes significance at 1 per cent. level.
† See Table 37 and Appendix A.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

however, that the analysis of questions involving percentages has been carried out on transformed values, so that column 3 is in transformed terms. There are difficulties about reconversion into the original units, and this is not necessary for our purpose, so column 2, also, is given in transformed terms to preserve comparability with column 3.

It will be seen that the percentages in the first columns vary from zero to over 50 per cent. Although only five values are greater than 25 per cent., there can be no doubt that many of the smaller differences would be large enough to worry the commercial survey practitioner. Despite this fact, comparison of columns 2 and 3 immediately shows that the size of the difference required to have given the experiment a 50 per cent. chance of detecting its significance was considerably larger, in general, than the observed differences.

It must be remembered that the residual mean squares which have been used as the basis of our power calculations have 24 degrees of freedom in Analysis A, and only 12 in the other two analyses. This implies that our estimates in the third columns of Table 39 are themselves subject to considerable sampling error, and must be treated cautiously.

Nevertheless, it is clear that, in general, the scale of our experiment was inadequate to decide the question of the statistical significance of the observed differences between control levels and assignment schemes. This deficiency is due to the fact that, in determining the size of the experiment, we had no previous knowledge of the variability of the material, such as would have enabled us to make power calculations in advance, and we did not expect the residual variability of quota sampling to be of such a high order.

We have looked at the quota sample results from two angles. In section 3.1, we presented the actual results and found that the effect of the different types of quota samples differed from question to question and that it was difficult to discern a systematic pattern. In section 3.3, we tested the significance of the differences and found that few of those between assignment schemes and control levels were statistically significant. In the present section, we have shown that the power of our experiment to detect these particular differences was low.

We must therefore regard this part of our experiment as rather inconclusive from a statistical point of view. The indications in section 3.1 were that some of the observed differences might be of practical importance, that the industrial control, for instance, seemed to make an important difference on many questions. If these differences appear to be of potential practical interest to quota sampling practitioners, they would repay further experimental study on a larger scale.

IV. *Conclusions*

In order to restrict the length of this paper, we have confined ourselves to what seemed the major aspects of quota sampling. This has meant that the subsidiary purposes of the experiment listed in section 1.4 have had only incidental mention. Four, in particular, deserve more attention: the operation of the social class control, the effect of location of interview, refusals and unproductive interviews and the order of quota filling. We believe that our experiment provides some useful findings on all these and we hope to publish them separately.

One other gap in this paper, dictated by considerations of length, must be borne in mind in interpreting the findings. We have discussed only *over-all* results for the quota and random samples; no breakdown analyses for age, sex and social class groups have been included. In practical survey work, results are invariably wanted for breakdowns of the sample and, if a sampling method is to commend itself for confident use, it should be shown to be unbiased for sub-groups, as well as the total sample. In this paper, we have had to confine ourselves to the latter; in a future paper, we shall subject the various samples of this experiment to the more stringent test of analyses by age, sex and social class. These analyses should also enable us to explain some of the differences between random and quota sample results which have been revealed by this experiment.

The remaining paragraphs of this paper are devoted to the conclusions we draw from the results presented. They fall into five groups: the different types of quota samples; bias; variability; comparison of random and quota sampling; and comments on the experiment itself. In order to avoid qualifying every conclusion we state, we emphasize that we fully appreciate the limited generality of our results. Firstly, what we have found refers to a particular group of questions. These were indeed chosen as typical examples of quota sample surveys, but this does not mean that our results necessarily apply to other questions. Secondly, our experiment

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

was, for reasons explained earlier, confined to three towns. Some may consider it safe to generalize from such a basis, but we make no claim to such generality.

Types of Quota Samples

We wanted to test whether the imposition of controls additional to the usual ones of age, sex and social class made any substantial difference to the results. We used two types of further control, one geographical and the other industrial. The former was more in the nature of an additional instruction than a statistically based control; and our reasons for using it were explained in part I. Whatever its basis, it certainly does not appear to have had any merit, as far as the results were concerned. The "landmarks" in each town were chosen somewhat arbitrarily and it is possible that they themselves led to some bias—such as might arise, for instance, if too many interviews were made in suburbs rather than in the town centre.

The industrial control, the potential value of which was suggested by earlier surveys, cannot be dismissed as valueless, although differences of statistical significance are few. It naturally helps to make the occupational distribution of the samples more accurate. It also makes the samples more representative with regard to other important factors, notably education, and thus acts as a brake on the tendency of quota samples to over-represent the more educated groups. On some other questions, as the results in section 3.1 show, the industrially controlled samples are closer to the check figures or random results than the other quota samples. We believe that an industrial control might well be used more in practice, especially now that recent Census data make quota setting as easy as, and more objective than, for the social class control. To what extent, if at all, such a control overlaps with the social class control is a question for further study. The industrial control is, of course, more difficult for the interviewer, and this has to be weighed against its advantages. It also leads naturally to a greater proportion of "place of business" interviews, which may or may not be desirable.

The other variation in quota sampling on which we experimented is the type of quota assignment. We showed in Part II that the age/sex and age/social class composition of the samples based on independent assignments differed markedly from those of the interrelated samples. Leaving aside the second of these bivariate comparisons (as it involves the social class control), we concluded that, as regards the joint age/sex distribution, the interrelated samples, which were based on Census data, were "more representative" than the independent ones. We expected, therefore, that they would give more accurate results on questions for which response is correlated with sex and age.

However, this does not appear to be the case. For most of our comparisons, the differences between the results from the two types are not statistically significant—this could be explained, as we have pointed out, by the low power of the experiment. But there is some evidence in section 3.1 that, on some questions the interrelated samples are rather *less* accurate than the independent ones. The most clear-cut example is that of occupation. It seems as though the additional constraint arising from the interrelation of controls forces interviewers to fill their cells more "unrepresentatively" in other respects. Our evidence on this is slight and also conflicting (on education, for example, the interrelated samples are better). All we can say is that our results do not allow us to conclude—as the analysis in part II suggested—that the results of interrelated samples are necessarily better than, or different from, those of the independent ones.

Bias in the Quota Samples

We have seen, first from the national survey quoted in part I and then from the experiment, that, on some fundamental questions, the quota samples were biased. Occupation and education were the most conspicuous cases. On most of the other questions, differences between quota results and check data or random sample results were relatively slight and we conclude that they do not afford evidence of other systematic biases in the quota samples. There are indeed differences, but—leaving aside questions of purely statistical significance—they are rarely of the order that would worry the commercial survey practitioner. The two biases noted are serious and should be corrected by additional control, if possible, and at any rate given more attention in quota sampling practice.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

These conclusions, as already noted, apply to the overall sample results only; no comparisons within sub-groups of the samples have yet been made.

Variability in Quota Samples

We have been able, in the manner explained in 3.1, to estimate the sampling variability of the quota samples and have found that, while varying from question to question, it is generally between one and three times as large as that of the random samples. The difference is presumably due to between-interviewer variability in the quota samples, a component that is not included in the estimate of the random variance. Although the experiment provides no evidence for this, we think that, for random samples, this component (which we believe to be largely due to the selection factor) is likely to be small.

The calculation of estimates of quota sampling variability was possible here only because of the replication included in the experimental design. This kind of replication is not carried out in quota sampling practice, and there is then no theoretical basis for estimating the sampling error. In spite of this, it is not uncommon for quota samplers to use the equivalent random sampling standard error as a rough estimate of that for the quota samples. If our experiment is at all typical, its results imply that this practice results in a considerable understatement of the total quota sampling variability. (This is apart from the fact that the quota samples are almost always multi-stage samples and that allowance should therefore be made for the contribution to the sampling error of the various stages.)

If sampling errors were to be estimated for national quota samples in the manner used in this paper, it would be necessary to select the first-stage sampling units at random, and to arrange for replicated samples within each selected unit. In this experiment, which was concerned with three towns only, no problem of selecting first stage districts arose.

Our conclusion from this experiment is that, on the whole, the quota samples were unbiased but subject to a variability considerably higher than that for random samples of the same size. Quota samples are, of course, cheaper, and in practice this cost factor has to be weighed against that of variability.

Random Sampling and Quota Sampling

The experiment has revealed relatively few major differences in results of the quota and random samples. This finding should be correctly interpreted; it does not mean that quota sampling is theoretically sound. We have, so to speak, one more "observation" to show that, in the hands of practitioners of long experience, quota sampling can give fairly accurate overall estimates. An unpublished analysis of the recent Hulton readership surveys was another example pointing in the same direction. Nor is the practical success of quota sampling as surprising as is sometimes suggested. Its explanation is largely that the three controls of sex, age and social class between them account, as they are designed to account, for a great proportion of the variability in answers to many questions. We have little doubt that the social class control, however crude, unreliable statistically and subjectively interpreted, goes a long way towards bringing the quota results into line.

But this practical success of quota sampling does not make it theoretically sound. For this reason alone, we do not think that it is a method suitable for surveys in which it is important that the results are derived (and known to be derived) from theoretically safe sampling methods.* In saying this, we are not forgetting the non-response problem. Our experiment has demonstrated this to a somewhat exaggerated degree and it is fair to make the general comment that the random samples in this experiment were not as good as many random samples in practice. Nevertheless, it is rare for the non-response rate to fall below 10–15 per cent. and, as long as this is so, the random samples cannot be regarded as free from danger of bias. Random sampling theory makes no allowance for the possibility that some of the balls in the urn might refuse to be taken from it while others happen not to be in the urn when the hand dips into it. This lack of correspondence between theory and practice in random sampling is not similar, however, to the weakness of quota sampling, which is the total absence of a theoretical framework. In random sampling we are in the position that, as regards about 80–90 per cent. of the sample, we know that we are on

* For example, the Government Social Survey has not used quota sampling methods for some years.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

sound theoretical foundations; as regards the remainder, we are partially in the dark, and this is a problem which must be reduced to negligible proportions if the random sampling of human populations is to conform to its theory. The Division is now planning an experiment with regard to this question and the related one of cheapening random sampling.

Non-response must not be regarded as solely a random sampling problem. We mentioned in section 2.1, for instance, that the recorded refusal rate in the quota samples was 8 per cent. Comparison of the record sheets suggests that interviewers recorded refusals with varying care and completeness; one of the organizations recorded an average refusal rate of 16 per cent. Other forms of non-response do not gain the same prominence in quota as in random sampling for the simple reason that there is no pre-selection of respondents. However, in the sense that some people may be systematically missed by the interviewers, non-response may be equally important, though generally unnoticed, in quota sampling.

Without wanting to belittle the drawbacks of quota sampling, we feel that statisticians have too easily dismissed a technique which often gives good results and has the virtue of economy. But quota sampling practitioners must not claim more for their method than is justified; they can reasonably claim that it has often worked well and that long practice has made them skilful in the operation of what is essentially an art. They cannot claim that it is theoretically sound.

The Weakness of the Experiment

It is useful, if perhaps unconventional, to conclude by emphasizing an obvious weakness of our experiment. Few of the differences shown were found to be *statistically* significant. As we have already said, the residual variability betewen interviewers was very high and the sensitivity of our experiment consequently low. It is useful to ask what we would have done had we been able to foresee this. We could not have increased the size of the experiment, because the effective limits on this were, as so often, cost, time and labour. Instead, we should undoubtedly have cut down the complexity of the experiment. As one instance, we might have confined ourselves to one area instead of spreading our limited resources over three towns. As a second, we might have been satisfied with one type of additional control, rather than two. As a third, the release of resources from the quota sampling side of the experiment might have enabled us to replicate the random results and improve our comparisons of the variability of the two methods.

The development of satisfactory experimental techniques is one of the outstanding methodological tasks of the social sciences. But it is an unavoidable fact that our experimental material is much more difficult to control than that of, say, the agriculturist, in the sense that, even after as many as possible of the main factors of an experiment are distinguished and controlled, there generally remains a great deal of uncontrolled, perhaps uncontrollable, variation. This is what we found in this experiment. If we had cut down the domain of study, we should, by concentrating our resources, have sacrificed knowledge of some effects, but we should have learnt more about the significance of others. We feel, in short, that, as things have turned out, we have been too ambitious and that, had we more narrowly limited the domain of study, we might have ended with a few firm conclusions, rather than many tentative ones. It seems to us that the social scientist has everything to gain from the importation into his field of the experimental techniques so successfully developed elsewhere. But the elegance and technical ease of application of these techniques must not lead him to forget the difficulty of his material; for the time being, he may often have to be satisfied with designs less complex and all-embracing than those which form the daily routine of his agricultural and industrial colleagues.

References

(1) MOSER, C. A. (1952), "Quota sampling", *J. R. Statist. Soc.*, A, **115**, 411–423.
(2) COCHRAN, W. G., & COX, G. M. (1950), *Experimental Designs*. New York. John Wiley and Sons, Inc.:
(3) DURBIN, J., & STUART, A. (1951), "Differences in response rates of experienced and inexperienced interviewers", *J. R. Statist. Soc.*, A, **114**, 163–206.
(4) BARTLETT, M. S. (1947), "The use of transformations", *Biometrics*, **3**, 39–52.
(5) QUENOUILLE, M. H. (1950), *Introductory Statistics*. London: Butterworth:
(6) NEYMAN, J., & TOKARSKA, B. (1936), "Errors of the second kind in testing student's hypothesis", *J. Amer. Statist. Ass.*, **31**, 318.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPENDIX A

SURVEY RESEARCH UNIT

LEISURE SURVEY

Serial Number of Informant.....

---

1 (*a*) I am from the Survey Research Unit, and we are trying to find out a few things about what people do in their spare time. Would you mind telling me, are there any things which you would like to spend more time on?

Yes 1
No 2
Don't know 3

(*b*) **If YES (1) to Q.1:** What, for instance? **(Record fully)**

.....

.....

.....

For office use

Y	X	0	1
2	3	4	5
6	7	8	9

ASK QUESTION 2 OF ALL WOMEN INFORMANTS. FOR MEN GO ON TO QUESTION 3.

2 Are you a housewife—that is, the person who is mainly responsible for domestic duties in your household?

Yes 1
No 2
Not applicable 3

ASK ALL.

3 (*a*) I know that your job makes a lot of difference to the amount of spare time you get, so would you mind telling me whether you have a paid job?

Has job 1
Has no job 2

If "Has Job" to Q.3 (*a*):

3 (*b*) What is your job? **(Obtain fullest possible description of occupation and industry.)**

Occupation .....

.....

Industry .....

.....

ASK Q.4–7 ONLY OF INFORMANTS WITH JOBS. FOR THOSE WITHOUT JOBS GO ON TO Q.8.

4 Is your job full-time or part-time? **(part-time means less than 30 hours per week)**

Full-time 1
Part-time 2
Not applicable ...3

5 On how many days a week are you at your job? **(Record as stated)**

.....

.....

.....

Not applicable 9

For office use

Y	X	0	1
2	3	4	5
6	7	8	

6 Roughly, how long does it take you to get to work? I only mean going to work, not coming home. **(Record as stated)**

.....

.....

Not applicable 9

For office use

Y	X	0	1
2	3	4	5
6	7	8	

7 (*a*) How do you generally get to work? **(Ring all mentioned)**

On foot 1
Bicycle 2
Motor cycle 3
Car 4
Public transport (bus, tram, train, etc.) 5
Not applicable 6

(*b*) **If PUBLIC TRANSPORT (5) to Q.7(*a*):** How much per week altogether do you spend on fares to and from work? **(Record as stated)**

.....

.....

Not applicable 9

For office use

Y	X	0	1
2	3	4	5
6	7	8	

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

ASK Q.8 ONWARDS OF ALL INFORMANTS

8 (*a*) Will you tell me, when did you last go to the pictures?

Within last 7 days 1
8-14 days ago 2
15-28 days ago 3
More than 28 days ago ...4
I never go 5
Don't know 6

(*b*) **If within last 7 days (1) to Q.8:** How many times have you been in the last seven days? **(Ring number stated)**

Don't know .....Y
Not applicable...X
1 2 3 4
5 6 7 8

9 During this last football season did you go in for any football pools?

Yes (alone) 1
Yes (shared) 2
No 3
Don't know 4

10 (*a*) Do you smoke?

Yes 1
No 2

(*b*) **If YES:** How many cigarettes did you smoke yesterday? **(Record as stated) (Number SMOKED is asked for, irrespective of when or by whom they were bought)**

.....

.....

.....

Not applicable 9

For office use

Y X 0 1
2 3 4 5
6 7 8

11 Do you hold a ticket in your own name for the public library?

Yes 1
No 2
Don't know 3

12 Did you read any daily morning newspapers yesterday? Which ones? **(If interview is on Monday, ask of previous Saturday)**

RING EVERY PAPER MENTIONED

None .....Y
Don't know X
Daily Mirror 0
Daily Graphic (Sketch) 1
Daily Express 2
Daily Mail 3
Daily Herald 4
News Chronicle 5
Daily Telegraph 6
Manchester Guardian 7
The Times 8
Daily Worker 9
Birmingham Gazette 91
Birmingham Post 92
Western Daily Press and Bristol Mirror 93
Scotsman .....
Glasgow Herald 94
Others (list below) 95
.....96

.....

.....

13 Did you read any Sunday newspapers last Sunday? Which ones?

RING EVERY PAPER MENTIONED

None .....Y
Don't know 95
News of the World X
The People 0
Sunday Express 1
Sunday Graphic 2
Sunday Pictorial 3
Sunday Chronicle 4
Sunday Dispatch 5
Reynold's News 6
Empire News 7
The Observer 8
Sunday Times 9
Birmingham Sunday Mercury ...91
Sunday Mail 92
Sunday Post 93
Others (list below) 94

.....

.....

14 Now I would like to ask you a few details about yourself and your household. Are you married?

("Divorced and married but living apart" should be coded "3")

Married 1
Single 2
Widowed and other 3

15 Where are you living? Would you show me on this card which applies to you?
(Please call by number)

At home 1
As a lodger or boarder with a family...2
In a hotel/hostel/boarding house/ hospital/institution 3
Elsewhere (give details below) 4

.....

.....

16 (*a*) **If AT HOME:** What kind of house is it? Would you show me on this card which applies to you?
(Please call by number)

Whole detached house 5
Whole semi-detached house 6
Whole terrace house 7
Self-contained flat 8
Other (give details below) 9
Not applicable .....Y

.....

.....

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(*b*) **If whole house (5, 6, 7) to Q.16(*a*):** Do you rent your house, or is it your own?

Rented 1
Own 2
Other (give details below) 3
Not applicable 4

.....

.....

.....

17 Now will you tell me who are the people living in your household?
Fill in first line for informant, whose age should be obtained. Other ages are only required if under 21.

Relationship to Informant	Sex	Age
1. ..... INFORMANT.....	M F	.....
2.	M F	.....
3.	M F	.....
4.	M F	.....
5.	M F	.....
6.	M F	.....
7.	M F	.....
8.	M F	.....
9.	M F	.....
10.	M F	.....
11.	M F	.....
12.	M F	.....

No. in Household aged:

0–4 ... ...
5–15 ... ...
16–20 ... ...
21 and over ... ...
TOTAL ... ...

18 Have any of you a motor car?
Yes 1
No 2
Don't know 3

19 Do you have a television set yet?
Yes 1
No 2

20 (*a*) Have you a telephone?
Yes 1
No 2

(*b*) **If YES:** Is it in the directory under your (family) name?
Yes 1
No 2
Don't know 3
Not applicable ...4

21 At what age did you finally stop receiving full-time education?

11 or under .....Y
12 X
13 0
14 1
15 2
16 3
17 4
18 5
19 6
20 or over 7
Don't know 8
Not yet finished 9

22 Now, one final question. Do you mind telling me from this card which income grade **your own** income last week fell into?

(*a*) **If Informant is working, add:** I mean, after deducting income tax and National Insurance, but including overtime and bonuses.

(*b*) **If informant is not working, add:** I mean, income of your own.
(Housewives' housekeeping money should not be included)

Group
None 1
Up to £3 2
Over £3, up to £5 3
Over £5, up to £7 10s. 4
Over £7 10s. up to £10 5
Over £10, up to £20 6
Over £20 7
Don't know 8
Refused 9

Name of Informant .....

.....

Address of Informant .....

.....

.....

Interviewer's No. ...../...../...../.....

RING DATE OF INTERVIEW

	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
APRIL	—	28	29	30	—	—	—
MAY	—	—	—	—	1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
JUNE	1	2	3	4	5	6	7

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

INTERVIEWER'S NUMBER ...../...../...../.....

APPENDIX B

Survey Research Unit

INTERVIEW RECORD

It is very important that this record should be filled in for EVERY INTERVIEW, OR ATTEMPTED INTERVIEW, IN ORDER OF OCCURRENCE, even if you were met by an immediate refusal or found out straight away that the subject did not fit into any of the needed quota cells.

Serial No. of Informant	Details of Informant: Sex	Age (estimate if necessary)*	Social Class	Name and Address	Date and Time of Interview	Location of Interview	Result of Interview	If Unproductive Interview Why Rejected	If Refusal, state: (a) reasons given for refusal, (b) if none given, what you think were the reasons for refusing. Also ring (a) or (b) as appropriate.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	M F			Name ..... Address	Date ..... Time of starting interview .....a.m. .....p.m.	Address .... H. S. F. Of. X	1 2 3 4	1 2 3 Other reason	(a) (b) ....
	M F			Name ..... Address	Date ..... Time of starting interview .....a.m. .....p.m.	Address .... H. S. F. Of. X	1 2 3 4	1 2 3 Other reason	(a) (b) ....
	M F			Name ..... Address	Date ..... Time of starting interview .....a.m. .....p.m.	Address .... H. S. F. Of. X	1 2 3 4	1 2 3 Other reason	(a) (b) ....
	M F			Name ..... Address	Date ..... Time of starting interview .....a.m. .....p.m.	Address .... H. S. F. Of. X	1 2 3 4	1 2 3 Other reason	(a) (b) ....
	M F			Name ..... Address	Date ..... Time of starting interview .....a.m. .....p.m.	Address .... H. S. F. Of. X	1 2 3 4	1 2 3 Other reason	(a) (b) ....

* Where estimated mark age with an asterisk.

CODES: *Location of Interview:* H—Home. S—Street. F—Factory. Of.—Office. X—Other.

Result of Interview: 1. Questionnaire completed. 2. Questionnaire partly completed. 3. Unproductive interview. 4. Refusal.

Unproductive Interview: 1. Did not fit age quota. 2. Did not fit social class quota. 3. Did not fit industrial quota.

APPENDIX C

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

* Where estimated mark age with an asterisk.

CODES: *Location of Interview:* H—Home. S—Street. F—Factory. Of.—Office. X—Other.

Result of Interview: 1. Questionnaire completed. 2. Questionnaire partly completed. 3. Successive interview. 4. Refusal.

Unproductive Interview: 1. Did not fit age quota. 2. Did not fit social class quota. 3. Did not fit industrial quota.

APPENDIX C

INTERVIEWER'S NUMBER ...../...../...../.....

Survey Research Unit

It is very important that this record sheet be filled in carefully for EVERY CALL.

INTERVIEW RECORD

Serial No. of Informant	*Details of Informant*			*First Call*		*Second Call*		*Third Call*		*Informant's Estimated*		*In Case of Refusal*
	Sex	*Name*	*Address*	*Date and Time*	*Result*	*Date and Time*	*Result*	*Date and Time*	*Result*	*Age*	*Social Class*	*State:* (a) *Reasons given for refusal.* (b) *If none given, what you think were the reasons for refusing. Also ring* (a) *or* (b) *as appropriate*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	M F			Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	1 2 3 4		(a) (b) ....
	M F			Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	1 2 3 4		(a) (b) ....
	M F			Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	1 2 3 4		(a) (b) ....
	M F			Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	1 2 3 4		(a) (b) ....
	M F			Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	Date: ..... Time of Calling: .....a.m. .....p.m.	1 2 3 4 5 6 7 8 9	1 2 3 4		(a) (b) ....

Code for Result:
1. Questionnaire completed.
2. Questionnaire partly completed (i.e., interview broken off).
3. Not at home or inconvenient time.
4. Away from home for a period.
5. Removed from this address.
6. Unknown at this address or address non-existent.
7. Deceased.
8. Ill or unsuitable for interview.
9. Interview refused.

Code for Age:
1. 20–29
2. 30–44
3. 45–64
4. 65 +

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Digitized by Arya Samaj Foundation Chennai and eGangotri

Appendix D

INDUSTRIAL CONTROL

1. *Distributive trades.*—All persons employed in retail and wholesale shops. This includes dealers in groceries, provisions, confectionery, tobacco, clothing, furniture, motor cars, electrical goods, coal, timber, metal, fish and so on. Also department stores, agricultural merchants, horse and livestock dealers and general exporters and importers.	Shop assistants. ,, cashiers. ,, accounts clerks. Storekeepers. Roundsmen. Window dressers. Branch managers. Buyers. Delivery van drivers. Travellers. Demonstrators.
2. *Transport and communications.*—All persons employed in public transport organizations (buses, trams, railways, air transport, shipping) and those employed by haulage contractors, taxi and car hire firms, coach firms, furniture removers, etc. Also all post office workers, and cable and wireless employees.	Bus drivers. Railway porters. Stevedores. G.P.O. linesmen. Long distance lorry drivers. Telephonists. Postmen. Ticket collectors. Office staff at airport or docks. Chauffeurs.
3. *Professional and miscellaneous services and public administration.*—Most of these persons will be office workers. All persons employed in insurance, finance, lawyers and solicitors' offices, hospitals, schools, etc. Also those in theatres, cinemas, and other places of entertainment, in hotels, public houses, restaurants and clubs and in businesses such as launderies, hairdressers, window cleaners, dry cleaners, photographers, undertakers, etc. Finally all those in local and national government offices.	Clergymen. Civil servants. Insurance clerks. Solicitor's clerks. Musicians. Nurses. Veterinary surgeons. Barmaids. Ironers in laundry. Domestic servants. Cinema commissionaires.
4. *Industry and manufacture.*—All persons employed in factories and works of every kind, in agriculture, building and contracting, fishing, public utilities (gas, electricity and water supplies), mining, ship building.	Market gardeners. Builder's labourers. Crane drivers. Miners. Glass blowers. Cotton spinners. Sheet metal workers. Rolling mill pressers. Fitters (all kinds). Weavers. Printers. French polishers.
5. *Not gainfully employed.*—All persons not in paid employment or in business on their own account.	Housewives. Retired persons. Temporarily unemployed. Invalids. Students. Pensioners.

Discussion on the Paper by C. A. Moser and A. Stuart

Mr. P. G. Gray: It gives me great pleasure to propose the vote of thanks and to congratulate the authors on presenting their data with such clarity. This clarity makes it possible for me to disagree with a number of their conclusions and to add some new ones.

On looking at the controls, I am glad to see that the age grouping used is better than the two examples of current practice quoted by Mr. Moser in his paper last year (this Journal, 1952, p. 411), in one of which the top age group was 45 and over and in the other 50 and over. This leads to too few old people in the sample. The top age group used in the present paper, 65 and over, is much better.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The social class control is a very slipshod affair. We are told that each of the three towns received the same quotas of highest, middle and lowest class. This acts as a strait jacket, with most unfortunate consequences, as we shall see later.

The industrial control—which does not appear to be in general use by the organizations taking part—is a good idea, though the grouping is not detailed enough.

The authors must be thankful that the geographical control did not introduce any measurable bias, for the idea is unsound. What prompted its use? I have looked at one piece of their evidence—which they refer to but do not give—and made an interesting discovery. The authors were supplied with a quota sample of 386 interviews in a large town and found that its distribution between the wards of the town differed very much from that to be expected. It differed so much that we looked at it more closely. We found that the proportion of the electorate entering the sample in each ward was closely related to the proportion of the electorate who were jurors. The correlation was as high as 0·8. As those familiar with our J index will know, this means that the wealthy wards were greatly over-represented. I think the authors were supplied, not with the straightforward sample they thought, but with a quota sample having a variable sampling fraction including twice as many in the highest economic groups. Small wonder they found an apparent geographical distortion. But this prompts a question. If one operates a quota sample with a variable sampling fraction including more of the wealthy, does it mean that the interviewers will tend to concentrate all their interviewing into relatively wealthy districts so that they may more easily fill their quotas?

In assessing the reliability of their quota samples the authors have relied firstly on comparisons with some special random samples, and secondly with the Census. In their efforts to be unprejudiced towards quota sampling they have been perhaps a little unfair to their random samples.

The footnote to the heading of Table 12* seems to have been rather an afterthought, for in the two age comparisons the random samples contain people aged 21–29 but they are compared—to the random sample's disadvantage—with the 20–29 age group of the Census. The authors say that the age distributions differ markedly from those of the Census, but they only find 4 significant differences out of 24 comparisons. However, a couple of sums show that in Edinburgh only 101 men and 142 women were interviewed. A footnote tells us that for 12 of the 101 men and 23 of the 142 women no age was obtained. This makes two of their significant differences look rather shaky.

It will be seen below the table that the authors decided to reweight the random sample results by age and were surprised when this appeared to give less accurate results. Reweighting can be useful but it must be done correctly. I can best make my point from Table 15 which deals with marital status.

Firstly, there ought to be a statement in the heading pointing out that the quota samples are of persons aged 20 and over while the random samples contain persons aged 21 and over. Thus, the unweighted random sample—column (*a*)—should, and does, contain more married men. This is because only 4 per cent. of 20-year-old men are married compared with 45 per cent. of those in the ten years group 20–29. In column (*b*) of the random samples the estimates have been made by treating the 20 year olds as if 45 per cent., not 4 per cent., were married. This makes the estimates worse. The authors should remove their incorrect estimates under column (*b*) from all their tables. The statement beneath the table about non-response being responsible is not correct. Indeed, throughout the paper the authors seem unnecessarily worried about the problem of non-response.

I think some of the differences they find in their tables can be explained. In Table 33 they note a difference in the proportion doing their football pools alone, and suggest that this may be "a reflection of the different industrial or social composition of the samples." But a few tables earlier show that the quota samples contain more persons living alone. One might expect people living alone to do their pools alone.

May I also suggest an explanation for Table 32. Do the authors appreciate the attraction of the cinema queue for the quota-interviewer? Here are a fairly static group of people with nothing to do neatly stratified into the 1*s.* 9*d.*'s on the right and 3*s.* 6*d.*'s on the left. Unfortunately, the chance of any person being in the queue varies with the frequency with which he goes. The queue over-represents the regular attenders.

I should like to make two points about Table 13. In the line dealing with personal service the random sample percentages in all cases are appreciably greater than the Census figures, and in two out of three cases are slightly greater than the industrially controlled quota samples, IIa, which are based on Ministry of Labour figures. I prefer to believe the random samples. Comparing the Census with the Ministry of Labour figures for May, 1951, it will be seen that the Census has half a million less women workers than the Ministry of Labour. That is because the Census had

* For details of adjustments in some tables suggested by the next three paragraphs see authors' reply.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

an ambiguous question. And the Ministry of Labour figures are likely to be underestimates, since not all women workers, particularly those in personal service, are insured. This affects a number of the authors' remarks under this Table.

My second point about Table 13 concerns the males in the manufacturing group. The national figure for this group is 30 per cent. Thus from the Census figures it is seen that Bristol and Edinburgh are near the national average, but that Birmingham with 47 per cent. is above it. Yet each of the three towns received the same quotas by social class; presumably they would be the national proportions. But for all organizations the definition of social class depends to some extent on occupation and income. Thus in Birmingham the industrial control must work against the strait jacket of the social class control towards a better sample. This accounts for the emergence of a between-town effect and town/control level interaction in the left-hand half of the analysis of variance given later. It also accounts for the emergence of the difference in income and education. The authors have failed to appreciate the basic weakness of setting equal groups by social class in each town.

The rather tentative conclusions of this paper were incorporated in the Social Survey's quota samples over five years ago. Indeed Table 12 of the paper given by the Social Survey to this Society in 1950 (this Journal, 1950, p. 150) gave a detailed example of a quota sheet. The main control was an industrial occupation one of greater detail than the one used here. Only for the housewives was there an economic group control. There was also an age control. These were *not* interrelated. Our quota sample design was evolved after many careful cross-analyses and adjustments of the control group boundaries. It represented, I think, the highest state of the art reached before we abandoned it in 1948 for the rather more scientific method of random sampling.

I should like to make one final point based on Table 36. I do not believe that replication makes it possible to estimate the sampling error of a quota sample. The authors have measured only that part of the error which is the variability of interviewers filling their quotas. The actual errors will be larger. We are told, for example, that four interviewers in Bristol got no manufacturing workers whatever. So you cannot imagine replication making it possible to calculate the error of the proportion of manufacturing workers in the sample. The quota variance is too small. On the other hand, with the factual items of Table 36 the between-interviewer effect for the random samples will be negligible, if the instructions and definitions have been adequate. This is a red herring. It is safe to say that the ratios in Table 36 are underestimates.

If we take the average for all the items we find 222 per cent. for the first column and 239 per cent. for the second. Thus, on either basis we may say that one random interview is worth about $2\frac{1}{4}$ times one quota interview. But we have found that a random interview costs only twice as much as a corresponding quota one, so it appears that a random sample yields more information per pound spent.

Mr. D. Newman (in seconding the vote of thanks): It is obvious that this paper represents a considerable amount of hard work both in the form of statistical analysis and of careful preliminary planning. The ideal way of carrying out this sort of research is to plan in advance the data to be collected and how to analyse them. That is precisely what the authors have done. When a large mass of information is available it is tempting to ask of the data questions which they were not designed to answer. I shall do my best not to fall into the trap.

I agree with Mr. Gray that the authors have been a little hard on the results they obtained from the random samples. They seem to expect them to agree fairly closely with the other outside figures that they have got. For example, they use as a standard in many cases the results of the 1951 census. That census was taken in April and this survey in the summer. Are we justified in assuming that the results of the latter should agree closely with those of the census? Certain seasonal movements would take place between the time of the census and the time of the survey. The total numbers given by the census results might not vary much from those in the survey, but the proportions of the various classes might differ.

For instance, we are told that one survey had to be taken during the holiday period, and I wonder whether this would affect the so-called upper classes more than the lower. The census is taken earlier in the year to avoid coinciding with the holiday period, but for the higher classes the holiday period is spread over a longer time than for the lower.

Perhaps where they have been most unfair to the sample results is where they quote, for comparison, not the census results, but estimated figures. They compare their figures for television-viewing with the estimates obtained by the B.B.C. I do not suggest that the B.B.C. got those estimates by other than the most impeccable methods, but presumably they are based on the sale of receiving licences. I remember seeing in a Scottish newspaper, some time after the new transmitter opened in Scotland, certain figures which pointed to the fact that the television licences sold were numbered in hundreds whereas the television sets sold were numbered in thousands. This

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

"dishonesty" factor would vary in different parts of the country and the only way to estimate it is by a sampling procedure. In comparing their television figures with the B.B.C. figures the authors are comparing two sampling methods. Possibly in a future investigation along these lines a better standard to take would be the results from a random sample taken at the same time, or at least in the same period. The objection to taking random sample results as a standard is that one has to face the problem of non-response, and we cannot be certain that the effect of non-response is not to bias the results. The authors have tackled this problem by re-weighting the results they got from the random samples. I appreciate Mr. Gray's point on age distribution, but there is another possible objection to this. As I understand it, they have standardized their results from the random samples so that they agree with the standard age distribution. That is all right provided that the sample taken of a particular age group is truly a random sample, but here we cannot be at all certain of that. I wondered whether the authors had thought of the other possibility, that of taking a sub-sample of the cases where the interviewers got no response and ensuring that some sort of answer was obtained from the individuals in that sub-sample. I realize that in this particular case that was not possible, but the authors were able to ensure that where on the first call it was not possible to get a response two further calls at least were made. Was there any difference between those cases in which a response was obtained immediately and those in which a response was obtained only on the second or third call? It would be reasonable to assume that the cases in which no response at all was obtained fell into the same class as those in which the results were obtained only after more than one call. Would the results be different if the estimates were made by assuming this and rating up accordingly?

I was glad to see that the authors corrected the degrees of freedom given in Table 7, but the only effect of that was to alter slightly the significance levels. The meaning of the age-class table is presumably that in meeting their independent requirements interviewers can at the same time automatically meet their inter-related requirements. One can only speculate how this can come about. Certain factors are quite easy to assess at once. One can determine sex at sight and also fairly accurately social class ; but it is a more difficult matter to determine age. The only explanation I can find for the results in the age-class cases is that the interviewers were subconsciously meeting the inter-related assignment at the same time as the others.

To return to the non-response problem, the method of standardizing the results after one has obtained them is perhaps not the most ideal from the theoretical point of view, but it does sometimes give quite reasonable answers. Have the authors considered the possibility of standardizing the results of quota samples with respect to, say, age, sex and class? What would be the effect if they did?

I think the authors have very rightly emphasized the fact that this is a very special investigation and it would be dangerous to generalize from it. Nevertheless it is almost inevitable that people will generalize, and that is to a certain extent one of the values of the paper. It will suggest faults and dangers which are likely to be met with in practice.

There are a number of questions one would like to ask the authors. Some, I assume, will be answered in the future work we are promised on these data, and I look forward very much to hearing the further results of this work.

The vote of thanks was put to the meeting and carried unanimously.

Dr. H. DURANT: I have been concerned to some extent with the rather chequered history of this project. Some of us at the British Institute of Public opinion were members of the committee who planned the experiment. After much discussion we felt very serious difficulties about the plan as proposed. We put those difficulties into writing on more than one occasion so that our views would be known. Nevertheless, if we had withdrawn, one part of the experiment would have collapsed. Later, another research organization kindly volunteered to take our place and we gladly withdrew.

Part of our difficulty with the design of the experiment has been touched upon by Mr. Gray. No organization really had proper class controls. Very few research organizations indeed have proper class controls for any local areas, and Mr. Gray has pointed out some of the difficulties which have arisen as a result of fixing arbitrary standards. It may be that this point has particular relevance to the validity of the comparisons of variance in Table 36.

Another problem was that in actual practice every organization concerned, if making arrangements for a local survey, would use a random sample. A study of the records of research organizations at the present time will probably show five or ten local surveys being arranged on a random basis. The reason for this is clear, namely, that the question of class control has not been adequately solved. The controls in a local survey tend to become very complicated and it is therefore much simpler in practice to use a random sample. The experiment, therefore, does not touch practice very closely.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It is stated that the human element enters into quota sampling. That is true. The authors have also demonstrated in an earlier paper that the human element enters into random sampling. In the paper given two years ago by one of the present authors (this Journal, 1951, p. 163) it will be found that there were differences in performances which had to be explained by reference to the questionnaire. There was not only a difference in the refusal rate but there were differences in the response rate, that is in actually finding the people at home. That is clearly a case in which the human element enters into the results achieved by random sampling. One must conclude—and this is my main point—that the human element enters into all systems of sampling of human population. In every type of sampling, the skill of the practitioner, whether commercial or non-commercial, consists in taking as much care as possible to reduce the effect of the human element.

With regard to the response rate and completion of quotas, dealt with on pp. 357 and 358, the refusal rate, I agree, appears, in practice, to be nearer 15 per cent. than 8 per cent. We found in one quota survey that only in 4 cases out of (quoting from memory) about 350 were the reasons for refusal related to the problems we were investigating. There were no grounds in the reasons given for refusing for believing that our results were thereby seriously affected. The refusals were distributed fairly equally over the age groups. We had more from women than from men. The usual reason was that they had to wash the baby, get their husband's supper, and so on.

Mr. Gray referred to quota sampling and cinema queues and we all appreciate his point. However, I recall one survey, based on a random sample, dealing with cinema-going. When the results were blown up on a national basis and published, they fell very short indeed of the totals available from other, official, sources. The teen-age group was very considerably under-represented; in fact, it was little more than 50 per cent. of what it should have been.

On p. 361 an explanation of the differences is given in terms of quota-fixing. I cannot go into the details but I would suggest that that explanation is at least inadequate. In the survey the contacts were asked to give their age. There is a well-known tendency for people to say "35" or "45" instead of their exact age. Two out of four age groups begin with an 0 and yet there is no bunching on the 0's. Again, for men the fixing is upwards and downwards, and for women only upwards. That may be so, in fact, but at least it raises a doubt in one's mind.

In many places it has been stressed that there is no theoretical basis for quota sampling surveys. The authors are writing as statisticians, pure and simple. If we turn our eyes to another discipline, sociology, there is, of course, a theoretical basis for quota sampling. One of the bases in sociological studies is that people think and behave differently according to their different circumstances. That, after all, is all that is being applied in quota sampling. The main circumstances—region, age, sex, social status are taken care of, because they are the most likely to affect the behaviour and attitudes of persons.

Therefore, whilst I accept what the authors of the paper say, "There is (statistically) no theoretical basis for quota sampling", I think that that remark has to be interpreted in a Pickwickian sense.

Fortunately in this country there has not been the strife between quota and random sampling that there has been in the States. All practitioners use both methods according to which they think most efficient in the light of the particular problems concerned. I, personally, am convinced that in the long run there will be developed a method of sampling of human populations which cannot exactly be called either quota or random sampling, because the elements of both will be inextricably mixed.

I should like to congratulate the authors of the paper. In all the preliminary discussions and in the later analyses I know how extraordinarily difficult it was to achieve what they have achieved, and I look forward to further results.

Dr. YATES: The controversy on the relative merits of random and quota sampling has an analogy in experimental design. There randomization plays an essential part. Its function is to ensure a valid estimate of error. The existence of a valid estimate of error has the very important practical consequence that when one is considering the results of experiments one does not have to be continually considering whether appropriate allowance has been made for extraneous factors (such as, in agriculture, a fertility gradient) which might, if randomization were not adopted, vitiate the results. This means that the scientist concerned with the interpretation of experimental evidence can devote his attention to the results themselves and their associated estimates of error, without continually looking over his shoulder and wondering whether some extraneous factor exists which will vitiate the conclusions based on these results.

The same, I think, applies in sampling. If we use the random method (with suitable controls, such as stratification) we can dismiss from our minds many of those potential disturbances of the results which exist in quota sampling. How troublesome these disturbances are is demonstrated by the fact that we have been devoting the whole of the present discussion to their consideration.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

An example of the sort of thing I have in mind is provided by the use of quota sampling for election forecasts. It has been unquestionably demonstrated that in many instances quota sampling is capable of giving very good forecasts, but occasionally things go badly wrong, as, for example, in the United States Presidential Election in 1948, when, on the basis of these quota samples, Mr. Truman's defeat was confidently predicted. There was a good deal of discussion at the time as to why the predictions were so wrong, and I do not wish to discuss the matter further here, but it is interesting to note that one of the causes of disturbance which I suggested at the time might be operating, namely that the samples might very well have contained fewer factory workers than they should, is borne out by the results of the present investigation. This may have been of particular consequence in the 1948 election, as this was the first election in which organized labour definitely took sides.

The point I want to mention particularly, however, is the effect of the 1948 failure on the 1952 predictions. In 1952 the quota sample results happened to give a very clear indication of the actual result, but so troubled were the forecasters by their 1948 failure that they made entirely excessive allowances for disturbances which did not in fact happen to be operating in 1952. This is a good illustration of the troubles we get into by permitting avoidable bias to creep into our results and then endeavouring to correct for it.

I do think these considerations are very material when sampling is required for serious scientific work in sociology, economics and so on.

I am glad that Mr. Gray has given us an explanation of why some of the random sampling results disagree with the statistics available for the whole population. A good deal has been said about the difficulties of random sampling. Quota sampling often merely conceals these difficulties. Non-contact is of course a serious matter, but it is not overcome by quota sampling, which is subject to non-contacts of a different and indeterminate type. In a random sample the amount of non-contact can be measured, its effect can be to a certain extent assessed by comparing differences between first and subsequent contacts, and if necessary, steps can be taken to reduce the amount of non-contact.

There are one or two minor points in the paper I should like to mention. I fully agree that the random sampling should be strengthened in future work, as is suggested in the last section of the paper. It should be strengthened not only by increase in numbers but by the reduction of that rather large amount of non-contact, and by a more detailed investigation of its effect. On the other hand, I am not certain that it would be a good plan to narrow the investigation so as to include only a single city. It is no use getting a very precise result for one city if in fact the results are quite different in other cities. If there are large differences between different cities the sooner we know about them the better. If there are no large differences then the combined results will give a better general estimate than would be the case if the investigation were confined to a single city.

In assessing the relative amount of information per interview in random and quota sampling we must remember that in quota sampling, biases in the selection of the sample are to some extent dependent on the interviewer who himself has to select the sample. Consequently, the relative amount of information depends on the number of interviewers as well as on the size of the sample. It cannot really be expressed as a simple factor of 2 : 1 suggested by Table 36. This sort of trouble always arises when there are biases affecting results.

Finally, may I congratulate the authors on a very useful piece of work. The paper has brought out very clearly both the general tendencies to bias in quota sampling and also the alarming differences between different quota samples. The investigation has undoubtedly taken a great deal of effort and the results are ably presented.

Mr. H. HENRY: As a member of one of the participating organizations, I congratulate the authors on the way they have summarized an extremely complex investigation.

I am a little uneasy about a point in para. 3.2. I have always had the impression that, though quota samples might produce biases (which one could take the necessary steps to control and eliminate), the fact that they involved restrictions would give a lower variability than would be the case with random samples, particularly where care is taken to avoid excessive "clustering." The suggestion that the reverse is the case makes me feel that further investigation on this point is necessary.

I suggest that to dismiss the variance arising from what is described as the "interviewing factor" as unimportant is not justified, even when dealing with what should be factual questions: this is so much a function of training and supervision that it can be extremely powerful. This is one reason why *all* social investigation by sampling and interview is an art rather than a science, whatever sampling system is employed. If it is in fact so, then the comparison between the two sets of variances shown in the paper is largely vitiated, since the random variances include none of this component in their calculations.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

It is important to note that both sets of figures are *estimates* of the variance of the corresponding sampling populations of means or percentages, and are themselves subject to sampling error. This means, in effect, that further experiments may yield very different estimates. The replication estimate in particular may be subject to a quite large sampling variation. A further point, though perhaps a minor one, is that the random sampling variances are calculated on the theoretical assumption of random selection. With only 75 per cent. completion of the design, there might be some exception to this.

Finally, to the *user* of statistics the most common and useful measure of sampling error is the standard error, not the variance. The comparison of sampling errors between the two sampling techniques, shown in Table 36, might therefore be better expressed in terms of standard errors and not variances. This would reduce the apparent discrepancy between the two from a ratio of 2·3 : 1 to a ratio of 1·5 : 1, and Mr. Gray's estimate that one random interview is worth $2\frac{1}{2}$ quota interviews should be adjusted accordingly.

Mr. Gray's explanation of the differences in the football pool figures, in terms of different sizes of families, is based on a misconception of what is meant in this inquiry by a "shared" entry. A shared entry does not usually involve the family at all, but means membership of a syndicate normally comprising groups of neighbours or of fellow-workers.

Mr. M. J. R. Healy: I should like to add my congratulations to the authors on this interesting and very useful piece of research. My remarks will be confined to a few aspects of the design of the experiment and its analysis. With regard to the design used, the authors seem to me to be unduly modest, since their design is in fact a $2 \times 2 \times 2$ factorial with split plots, split-plot confounding and a dummy treatment. One result of this complexity has been the division of the analysis of variance into two separate portions. This is a measure to be avoided wherever possible, and I think that at any rate the residual sums of squares might have been pooled, with a resulting increase of precision in the comparisons. It would have simplified the analysis and interpretation considerably if the control levels had constituted a three-level factor—normal controls, extra industrial control and extra geographical control—with each organization using all three types of control. This would cut down the number of interviews to 60 per interviewer, and I realize that this might have made it difficult to fill the quotas.

The authors have wisely emphasized that significance tests are not the be-all and end-all of experimental analysis. In view of this it is disappointing on turning to Table 37 to find nothing but a constellation of stars. The magnitudes of some of the effects can be judged from Table 38, but even here the signs are not given. The authors state that one interviewer in Organization 4 produced some aberrant results and was subsequently dismissed for unsatisfactory work. It is clear from the tables that this interviwer has been at any rate the partial cause of some puzzling discrepancies and presumably the estimated error has also been inflated. It might have been better to have rejected her figures completely, completing the analyses by a missing plot technique.

Mr. Emmett: I should like to comment on the second section of the paper concerning the interrelation of controls. The analysis of Table 7 is unsatisfactory in several ways. First the marginal totals for the two sexes and the four age groups differ widely from the expected values. Interviewers must be allowed some latitude in filling their quotas, but the large discrepancies noted here are far greater than I have ever seen. Naturally, with such large marginal total differences, high values of χ^2 must be expected. Furthermore, since the social class quotas set by the four organizations differ from one another, the totals in respect of social class in this table necessarily differ from the expected values and this also contributes towards a high value of χ^2. However, quite apart from these discrepancies, the independent samples unquestionably differ from expectation in a number of ways. Analysis of similar samples in the past have shown no such differences, and for this reason, if for no other, careful note should be taken of the authors' warning against generalizing from these results. One further point from this table concerns the number of degrees of freedom appropriate to the analysis. The figure printed in the paper is 17, which Mr. Moser amended in reading to 23. What the correct figure should be is uncertain, the uncertainty arising it seems, because the quota controls are not true linear constraints but only "approximate constraints."

In considering the industrially controlled samples it should be noted that the controls are set on figures relating to the labour exchanges in the three towns, which may well differ from the population figures. Had census data been available, improved quotas could have been set which might have shown the industrially controlled samples in a better light. As it is, they are necessarily distorted by the unrealistic demands made by the quotas.

Finally, the lack of significant differences between level I and level II results should be treated with caution. All the interviewers in the experiment were experienced in using not only controls

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

on age, sex and social status (the basic level 1 controls), but invariably used a fourth control as well—generally some simple control such as the proportion of housewives to be obtained or the proportion of persons gainfully employed and so on. Their performance in this experiment may then have been influenced by their experience in a slightly more complicated system.

The following contributions were received in writing after the meeting:

Mr. E. RUDD: The authors are incorrect in using (in section 3.1) the numbers of licensed cars for an estimate of the proportion of households owning cars. To do so ignores the appreciable proportion of cars owned by businesses.

Mr. T. CORLETT: The Electoral Register at the time it was used for the random samples in this experiment could contain hardly anyone under the age of 21. I hope that in their final version the authors will alter the definition of their lowest age group in Table 12 to read "21–29", not "20–29", and will also amend their Census figures accordingly. This can be done quite satisfactorily by excluding from the "20–29" figures for each of the three towns the national proportion of this group aged under 21 (8·8 per cent. in the case of males, 9·6 per cent. for females).*

Twice in the paper the authors "explain" a non-significant difference. For example, immediately below Table 12 it is stated: "The random sample sex percentages differ from the Census figures by less than one standard error; the slight under-representation of males in Birmingham and Edinburgh is due to non-response and is not uncommon in random samples". Surely, if the first of these sentences is true, the only proper conclusion for the second is that the "slight under-representation" may very well be due to chance? Alternatively, if the authors' "explanation" is to stand, one may fairly ask them also to find one for what can with equal justice be called "the slight *over*-representation of males in Bristol"!

Again, in their comments on Table 13, the authors say that "none of the random distributions differs significantly from the Census results", and yet a few sentences later we read: "Transport workers are on the whole under-represented, while there are too many workers in commerce and finance . . . ".

Finally, I think that the authors would do well to consider very carefully the statement of their general conclusions which appears in the later pages. This long statement contains a number of eminently quotable sentences in defence of quota sampling, and these will undoubtedly be quoted very widely, not without an ascription to the authors, to the distinguished head of their Division and to the eminent institution to which they belong. In view of this and of the fact that many people may draw rather different conclusions from the data, the authors should weigh very carefully the words to which they will inevitably lend the weight of such high academic authority.

Mr. MASON: The importance of Mr. Henry's main comment deserves to be stressed. It appears a great pity that finance prevented the random sample *itself* being replicated, for the practical estimate of variance obtained from two "random" samples, in view of the 25 per cent. non-response rate, might well have been comparable with that obtained for the quota samples. It seems fundamental to find out to what extent the variance of random samples in practice agrees with that in the text-books. Split samples conducted on lines which are not strictly random do, in practice, appear constantly to reveal a remarkably small variance, and it is conjecturable whether this variance is really appreciably greater than that for "random" samples carried out in the practical social fields. It is also certain that any biases introduced in other ways through lack of control on questionnaire, etc., will greatly outweigh any differences due to the sample structures themselves. In many market research fields, fortunately, the gradients or relationships are much more important than the magnitudes themselves.

I feel Dr. Yates's hopes for a trend towards pure random sampling must remain idealistic; in many fields no suitable list can possibly be procured. Even where working from specific names on electoral rolls, movements of population make it quite possible for non-response to be irreducible below an undesirably high figure.

Market researchers and users will welcome this promising study, since their main interest lies in working towards the most practical reliable economic sampling method that can be devised. One of the merits of the paper is that an outline of pitfalls serves to stress how essential experience and judgment must be, both in the planning and fieldwork, and in the ultimate interpretation. But these are the makings of any profession.

* This suggestion has been adopted. See authors' reply.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Mr. L. Moss: As I understand it the conclusion of this paper is that in some circumstances some forms of quota sampling appear to produce results which indicate that it is a practical method of working. If this conclusion were soundly based, it would be a matter of some importance for a Government organization which under present-day conditions must show that it is operating as economically as possible.

The authors, however, go out of their way to say "that they do not think that quota sampling is a method suitable for surveys in which it is important that the results are derived from theoretically safe sampling methods".

The important aspect of theory in any field is that it provides a logical basis for action. It enables us to know what we are doing and why we are doing it. This is why the Social Survey uses random and probability sampling. With the aid of the theory and the working practice built up on the basis of the theory, we can deal with the practical everyday problems which arise in drawing a sample and contacting the selected individuals and we know where we stand with the results.

According to this paper, and from our experience of the published work of some studies based on quota sampling, we know that the method has produced good results on occasions. What we do not know is in what circumstances it can be depended on to produce good results, and for the occasions when it does produce good results we do not know why it does so.

It is clear from this paper that it is a variable method, and that its application depends on knowing something about the subject under investigation beforehand. One might indeed say that it is a safe method to use only when one knows to some extent what some of the answers to any problem under investigation should be before the work has been done.

And without such information, and even to a large extent with it, the method is not one in which the investigator has full control over his material. In the first place, he is not in full control of his investigators, who, as this paper shows in some detail, are free to affect considerably the results they get. And secondly, the kind of controls actually laid down by the organization may very much affect the results. Some of the controls which appear to be in fairly general use do not seem to me very good. I am not impressed by the social class control, and neither have I seen anywhere any detailed justification and explanation of it.

In fact, the whole method of controlling a sample in the way usual to quota samplers seems to me somewhat doubtful. It is perfectly possible to control broadly the major demographic variables which you think are at work, and fail to control other variables which are important but about which you know nothing until your inquiry has been made. Thus it is common in budgetary inquiries to get a relatively low response, perhaps not more than 50 to 60 per cent. of the names originally chosen, and then to find that even with this low response rate the people giving you the material represent demographically the given population fairly closely. At the same time it is clear that in one very important aspect they are a special group. They are people who are willing to keep record books. We do not know much about them, but their spending and saving habits may not be the same as those of the population as a whole. In this particular case if we were to look at the demographic composition of those who co-operate we might satisfy ourselves that we had a good sample of the population, but I think without a great deal more information on the characteristics of those who co-operate and those who do not we might very badly mislead ourselves. I think this is a good illustration of the fact that broad demographic controls do not take you very far.

In some spheres of work, however, some form of quota sampling may produce results on which decisions can be taken for the reason that characteristics such as opinions and other facts may be widely dispersed through all sectors of the population, so that one loses very little on the kind of bias in selection which arises in quota sampling. At this stage it would be useful to know when, in general, quota sampling works and when it does not, and what it is about the nature of particular problems that seems to make quota sampling applicable and usable or completely hopeless. There may be in the data collected for this inquiry some answers to these questions. The paper does not deal with what happens when the results are broken down. Without this further work there may be a danger of some arguing that *some* of the results justify the *general* use of quota sampling. So it seems important to continue with the work initiated here. It may be, too, that some of the controls can be elaborated with reference to factors which have not been dealt with in this inquiry, and above all to the fact that different organizations get different results. The industrial distribution factor was used by the Social Survey towards the end of the war when we did a lot of work in places of work and it was possible to produce results which were fairly reliable. I am not too sure that it would be as easy to operate that kind of control today.

It is important to bring the discussion about the facts connected with different forms of sampling into the open, and I think that the authors have rendered a service to all field research workers by raising this issue and bringing forward some systematic material for consideration. I hope they will look at some of the questions I have raised.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The authors subsequently replied in writing as follows:

We entirely agree with Dr. Yates's admirable re-statement of the classical case against quota sampling, which is elaborated by Mr. Moss. It is for the sampling practitioner to decide whether the disadvantages of "continually looking over his shoulder" are compensated by the cheapness of quota sampling.

In denying a theoretical framework to quota sampling, we were using the terms in a purely statistical sense, and Dr. Durant's emphasis on its sociological basis does not affect our argument. Also, as Mr. Moss points out, the quota control of obvious demographic variables, even if this could be achieved with precision, does not ensure control of other variables which are related to the inquiry.

We should be very sorry to see our general conclusions torn from their context, which seems to be what Mr. Corlett fears, but we emphatically disagree with his implication that we should have been influenced by this fear. Some people will disagree with our conclusions, and some speakers have indeed already done so, but this is after all a commonplace of research in the social sciences.

We hope that in trying to avoid the usual academic prejudice against quota sampling we have not erred in the opposite direction, as Mr. Newman and Mr. Gray suggest. Mr. Newman cites the effect of seasonal factors on the comparison with Census data. It was unfortunate that one-quarter of the experiment had to be carried out three months later than the remainder, but this time-lag was forced on us by the differences between Dr. Durant and the remainder of the Committee, which have been referred to in the discussion. In fairness to the other organizations, we should say that the resolution of these difficulties would have required a far greater number of interviewers than any other organization had at its disposal. Apart from the higher non-response rate, we doubt whether the time-lag affected the results very much. We agree with Mr. Newman that the comparisons with the non-Census data are only approximate and, although we stressed this in the paper, it might have been better if they had been omitted altogether. We are grateful to Mr. Rudd for pointing out our error in taking the official figures of "private" motor-cars to refer to cars in private ownership in the ordinary sense. This probably explains the differences commented on under Table 19.

Mr. Gray and Mr. Corlett have both commented on Table 12, and Mr. Gray has also raised the question of the random sample re-weighting. It is true, as our footnote to Table 12 (now transferred to Table 13) points out, that the random samples refer to the population aged 21 and over, the Census and quota samples to that aged 20 and over. This difference, which is numerically very slight, applies equally to the later tables, and perhaps we should, as Mr. Gray suggests, have pointed to it not just once but in subsequent tables. We have followed Mr. Corlett's suggestion to re-calculate the Census figures in Table 12 (and to redefine the lowest age-group), and the corrected figures have been substituted in the table. These are closer to the Census results than the original ones, but the differences marked as significant in the table remain so with the revised figures.

We acknowledge that the corrected figures should have been used for the re-weighting in preference to the original ones (they cannot be regarded as the "correct" weights since they are adjusted according to national proportions; town figures are not available for the separate years in the 20–29 age-group). However, the effect of this on the results is negligible ; even for marital status, which is an extreme example, it never alters the percentage by more than ·2. The more substantial point arising from Mr. Gray's remarks is that—weighted or unweighted—the random samples do not include any 20-year-olds, while about 2 per cent. of the Census population aged 20 and over and of the quota samples are in this year-group. While Mr. Gray is right in saying that—on the question of marital status—this difference in coverage is to the disadvantage of the random samples, the effect is again slight. This can be judged from the national proportions (married) of the population aged 20 and over, and 21 and over respectively:

Males—20 and over, 74·4 per cent.	*Females*—20 and over, 66·0 per cent.
21 and over, 75·3 ,,	21 and over, 66·7 ,,

The differences are in the direction indicated by Mr. Gray but they are numerically small. Although the difference in coverage is, as Mr. Gray's dramatic example made clear, important when the lowest age-group is taken by itself the effect is swamped when all the age-groups are combined, as they are in all our tables.

In this connection we must mention that, in doing some calculations occasioned by Mr. Gray's remarks, we discovered an error in the computational layout for our random sample re-weighting.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Although this is a separate issue from those raised in the discussion, we feel that it should be brought to the notice of readers. We have re-calculated all the random sample (*b*) figures and substituted the correct figures in the paper. As it happens, one of the few tables on which the corrections make any appreciable difference is that dealing with marital status, where they bring the random sample (*b*) proportions more into line with the Census data and with what might have been expected. Mr. Gray's distrust of the original figures in this column was therefore justified, although the main reason proved to be the error just mentioned. We regret the error and the confusion it has caused.

Dr. Yates and Mr. Healy have made some interesting comments on our experimental design. Although we did not feel that the spread over the three towns brought us much gain, we appreciate that it is in general unwise and unprofitable to confine the experiment to too small a domain. We must confess to Mr. Healy that we were not aware of the correct nomenclature for our design. Sheer operational complexity prevented us from making the control-level a three-level factor, but we agree that it would have been better to pool the residual sums of squares at any rate. In view of the importance of the personal element in quota sampling, we thought it inadvisable to reject the extreme interviewer in organization 4.

We plead guilty to the constellation of stars in Table 37, our partial excuse being lack of space. Mr. Healy approves our general lack of emphasis on significance tests, while Mr. Corlett takes us to task for this, in two specific instances. In the first, we could have been more explicit. The sex of virtually all the non-respondents was known, and it was a fact that, in Birmingham and Edinburgh, the under-representation of males was due to non-response, while the over-representation of males in Bristol was not accounted for by non-response. In the second, it seems to us reasonable to comment on differences between corresponding items in two distributions even if the two distributions taken as a whole do not differ significantly from each other.

We agree with several comments made by Mr. Gray, which are criticisms of general quota sampling practice rather than of this experiment. His and other criticisms of the social class control are very much to the point, but despite its vulnerability it would be unrealistic to carry out a quota sampling experiment without it. The setting of social class quotas for the three towns was left to the organizations, and they each preferred not to vary their quotas from town to town, generally using national quotas. The disadvantages of this were indeed appreciated in advance. The setting of social class quotas is admittedly difficult for local areas but, as we said in the paper, this is only an accentuated form of the difficulty of setting such quotas, whatever the area. We cannot accept Dr. Durant's statement that "every organization concerned, if making arrangements for a local survey, would use a random sample". Local surveys have been, and are, carried out by quota sampling.

Mr. Emmett has made several comments on Table 7. We ourselves were surprised at the discrepancies in quota filling to which he refers, but checks have confirmed that the figures are correct. He is right in his remarks about the degrees of freedom. The problem of deciding how many degrees of freedom to use in such a situation is formidable: we adopted the conservative course—which gave the least chance of significant results—of ignoring those constraints which were not observed in practice.

Mr. Newman's suggestion that independently controlled quota samples could be interrelated by standardization after selection is an interesting one, which we would like to see carried out.

The industrial control was based on Ministry of Labour figures and it is true that the Census data would have been preferable had they been available. Even so, the control made a fair difference on many questions. The geographical control was, as we said in the paper, a failure. Mr. Gray asks us what prompted its use. The answer is partly that one or two organizations expressed the view that lack of interviewing spread was a problem in quota sampling, and partly that our previous analysis of geographical spread (referred to in section 1.3) produced disquieting results. We thank Mr. Gray for drawing our attention to the possibility that one of the samples in this analysis might be based on variable sampling fractions. On inquiry this proved to have been the case. However, other samples in the same analysis produced even higher discrepancies from expectation.

Several speakers have discussed non-response. Mr. Gray believes us to be unnecessarily worried about it, but we think that he and most survey practitioners would agree with us that it is one of the main outstanding problems of random sampling practice. We agree with Mr. Newman's remarks on non-response; as we emphasized in the paper, re-weighting of the random samples in no way corrects any unrepresentativeness arising within the age and sex groups. We have not so far carried out an analysis by order of call, but intend to do so. As Dr. Yates stressed, and Dr. Durant illustrated, quota sampling does not overcome the non-response problem. It may be of interest to give the refusal rates found in this experiment, by sex, age and social class:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

	Per cent.		*Per cent.*		*Per cent.*
Males	6·1	20–29	4·6	Upper class	12·2
Females	8·9	30–44	6·1	Middle class	9·7
		45–64	11·0	Lower class	6·3
		65+	7·5		

Mr. Henry and Mr. Mason both stress our point that, because of between-interviewer differences in non-achievement, the random sample variability will be larger than shown in our analysis. Although, as Mr. Henry says, the interviewing factor cannot be neglected, we still think it reasonable to suppose (the point cannot be proved from our data) that most of the difference between the variability of the two methods arises from the selection factor in quota sampling. We agree with Dr. Durant and others that the human element enters into all methods of sampling, but it clearly has a much greater chance of showing itself in quota than in random sampling.

We do not agree with Mr. Gray that replication does not make it possible to estimate the sampling error of a quota sample, since in repeated samples the results of any interviewer, and therefore of all interviewers combined, will have a sampling distribution. However, the estimates are of course subject to the assumptions and qualifications stated in the paper. They are also subject, as Mr. Henry has pointed out, to sampling fluctuations. This was one reason why we were cautious in interpreting the ratios of quota to random sampling variances. Another reason was that the cost ratio of the two methods seems to vary a good deal between organizations. Taking our variance estimates and the cost ratio of 2 : 1 quoted by Mr. Gray, we agree with the conclusion he draws. But we do not claim generality for our estimates, and think that this question should be studied further. In answer to another of Mr. Henry's points, variance ratios rather than their square roots are used in measuring efficiency, because in general variances and not standard deviations are inversely proportional to the number of observations taken.

Finally, on two comments concerning individual questions. Mr. Gray's point on football pools has already been discussed by Mr. Henry. We appreciate his remark on the attraction of the cinema queue to quota interviewers. This was the implication in our statement above Table 32. We went on to suggest that the difference between the quota and random sample proportions might also be due to a relationship between non-response in the random samples and film-going. Figures quoted in Table 15 of the paper to this Society in 1950 by himself and Mr. Corlett suggest that this is a reasonable supposition.

We should like to thank the speakers for their careful reading of our paper, and for their interesting contributions.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Robert Gordon Carpenter.
Ann Cartwright.
Robert Maurice Collinge.
Albert Ernest Jones.
Hans Kellerer.
Kenneth William Henry Liminton.
David John Newell.
William Richard Stewart.
Kenneth Wilson.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A Comment on a Criterion of Efficiency in Local Administration*

In a note published in a recent issue of this Journal† Mr. K. S. Lomax examined some statistics of local government administration, and concluded that "with regard to administrative cost the advantage certainly lies with the larger unit". This note examines some of the arguments employed, and suggests that what truth there is in that conclusion is of extremely limited interest and does not lead to the policy implications that a plain reading of that note might suggest.

Mr. Lomax considers the ratio of administrative expenditure to the total expenditure of a local authority as an index of efficiency. The lower this ratio the more efficient is the municipality. He further shows from figures he has available that there is a significant negative correlation between this ratio and the total expenditure of the municipality—used as an index of size—and this negative correlation persists through various transformations of the variables.

It is apparent that the level of administrative expenditure in a local authority is a function of its size, and an examination of the figures used by Mr. Lomax suggests that a simple linear relationship gives an adequate description of the dependence of administrative expenditure (z) on total expenditure (x); thus

$$z = a + bx. \qquad (1)$$

In consequence the ratio z/x used by Mr. Lomax follows the hyperbolic form

$$z/x = a/x + b, \qquad (2)$$

so that provided a is positive there will be a negative association between this ratio and the value of x. This hyperbolic form is, in fact, quite evident in the scatter diagram given in the note quoted.

On fitting (1) to the data by least squares the following estimate was obtained

$$z = 5{,}950 + 0{\cdot}0016x, \qquad (3)$$

with a correlation coefficient of 0·95; the units of z and x being £'s per annum. The equation (1) has a straightforward interpretation. Administrative expenditure in a local authority is the sum of two parts: the first is a constant and represents the essentials for any authority however small, including some sort of basic minimum town clerk's salary and the like; the second part is variable and depends on the magnitude of the authority's activities.

So long as there is this positive constant expenditure it follows that Mr. Lomax will detect a negative correlation between the variables he examines. This negative correlation is not in dispute here: but an argument that large towns are more efficiently administered than small towns is on the above showing reduced to an argument of the kind that if the population lived in larger towns there would be fewer town clerks to pay.

Without wishing to obscure the argument we add two further points. First, the regression (3) is to be preferrred to the regressions quoted by Mr. Lomax, since it expresses a relationship between variables which it may be supposed describes the behaviour of some decision maker. That is, it seems more plausible to regard the absolute value of administrative expenditure as being the subject of someone's (say the town council's) decision than does its ratio to total expenditure. Another reason is that the scatter of observations is substantially linear, whereas the ratio z/x requires some transformation which is *a priori* arbitrary in order to achieve linearity. Little significance is to be attached to the fact that the correlation coefficient quoted here is higher than that of 0·85 found by Mr. Lomax between log log z/x and log log x since different variances are involved.

So much for the method which Mr. Lomax has used for the analysis of his data. Our second point concerns the title of his note, "A Criterion for Efficiency in Local Administration". It

* This note has arisen out of discussions held at the Department of Applied Economics, University of Cambridge, between J. A. C. Brown, E. B. Butler, Phyllis Deane, S. J. Prais and J. E. G. Utting.

† "A Criterion of Efficiency in Local Administration" by K. S. Lomax in *J. R. Statist. Soc.*, 115 (1952), pp. 521–3. The data on which his note was based have been supplied to us by Mr. Lomax, and we should like to thank him for this and other assistance which he has given us. Mr. Lomax has also shown us some correspondence he had with Mr. L. G. K. Starke who, like ourselves, pointed out that the scatter diagram was strongly suggestive of a simple hyperbola.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

seems to us that in any case his data will not bear this interpretation. He assumes that the smaller the ratio of administrative expenditure to total expenditure the more "efficient" the authority must be, or in other words that of two authorities with the same administrative expenditure, that which has the larger total expenditure is the more efficient. It is not difficult, however, to see why total expenditure might be larger without in any way affecting either the total amount of administration or its cost.

For instance, Mr. Lomax appears to include loan charges in total expenditure; this implies that an authority which borrowed large sums of money in times of "dear money" will appear more efficient than one which borrowed mainly in times of "cheap money". Again, an authority which, owing to its geographical situation, has difficult problems of sewage disposal or water supply—making it costly to deal with technically but no more costly to administer—will appear more efficient than one with less costly technical problems. Or it is possible that by spending a little more on administration an authority can effect a reorganization which will enable it to provide the same services at lower total cost; yet by Mr. Lomax's criterion it will appear less efficient than before.

A glance at Mr. Lomax's own scatter diagram shows how much the relative proportions of administrative expenditure can vary for county boroughs with about the same total expenditure. It is reasonable to suppose that influences of the above kind are at work. Judgments on relative efficiencies based on such evidence alone would be superficial.

Nor is it obvious how an observed tendency for higher relative administrative costs to be associated with smaller total expenditures could in itself throw useful light on so complex a matter as the efficiency of local authorities. Certainly it cannot if one chooses, as Mr. Lomax does, as an index of administrative costs, wages and salaries in the town clerk's department. Though Mr. Lomax refers in his final paragraph to certain disadvantages of large towns, he fails to recognize that these disadvantages give rise to costs, both administrative and other, which are largely incurred outside the town clerk's department. These very disadvantages could conceivably create an illusion of efficiency as judged by Mr. Lomax's criterion. The choice of this index moreover ignores the fact that administration performed in the town clerk's department in the smaller local authorities is, in the larger authorities, specialized and segregated with separate service departments. The inclusion by Mr. Lomax of expenditures on trading services in his total expenditures makes matters worse; for the contribution of the town clerk's department to the administration of a large authority's trading services must be negligible.

* * * *

Mr. K. S. LOMAX has replied to the above comment as follows:

I find myself in complete disagreement with almost the entire chain of reasoning in the above comment.

The basis of my original note, stated quite clearly in the second paragraph, was the question whether administrative costs vary in proportion to total expenditure. I was interested in variation with total expenditure of the ratio administrative costs/total expenditure. Since I used regression analysis with corresponding tests of significance to examine this behaviour my variables had to be administrative costs/total expenditure, and, total expenditure. These were my fundamental variables. I could not take regression of administrative costs (z) on total expenditure (x) in the form $z = a + bx$ and then divide through by x to see what happens to z/x for several reasons:

(i) This is not permissible with a regression equation. If it is desired to know what happens to z/x for changes in x, the regression of z/x on x must be taken. Otherwise the parameters would be biased.

(ii) The fundamental variables being z/x and x, there is a spurious element in the correlation of z and x. Indeed the apparent linearity in the relationship between z and x is nothing more than the well-known tendency for a "part" to be linearly related with the corresponding "whole"—a generalized Engel's law. The high value of 0·95 for the correlation coefficient in the case of equation (3) is thus of no significance.

(iii) In fact the linear form is not even an adequate representation of the relationship between z and x. If the analysis of variance is set up it is found that the second-order term say, cx^2 in $z = a + bx + cx^2$ is *not* insignificant—a situation I was particularly careful to avoid. Far less confidence can be placed in second or higher order curves than in linear relationships.

The Cambridge comment in fact suggests $z = a + bx$ (equation 1), but even if the linear regression of z/x on $1/x$ (equation 2) had been taken, the fit would have been inferior to the linear log log relationship in my note. This is important because, once the decision has been made as

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to which variable is to be taken as independent and which dependent, goodness of fit is the only criterion to use in comparing the suitability of different regression functions. A regression equation is not an expression of a "law", and the "interpretation" of equation (1) given in the above note is largely irrelevant.

The second part of the comment seems, again, to be based on a misunderstanding of my objective. Of course, there are particular reasons why administrative costs vary in proportion to total expenditure for different authorities but there is no reason to expect that those mentioned in the above contribution are either appreciable in magnitude or correlated with size of authority, and it was only the general tendency exhibited for variation in size with which I was concerned. It is surely absurd to suggest, for example, that the large cities all have low administrative costs per £1,000 of total expenditure because they have all borrowed in times of dear money or have difficult problems of sewage disposal. The writers' argument may apply to odd individual cases, but equally clearly there will be municipalities of which directly opposing suggestions are true. Some authorities will have borrowed relatively cheaply, others dearly. But such effects are small in relation to total expenditure and are unlikely to affect the general trend. My concern was whether any tendency regarding returns to scale of administration was suggested by the data. If the criticisms of my note were justified, the scatter diagram would in fact have consisted of a completely random scatter of points. Certainly no good-fitting relationship of the kind obtained by the writers themselves would have been obtained.

The one particular factor mentioned which is claimed to be correlated with size is the assertion that some of the functions of Clerks in smaller authorities are dispersed among other departments in larger units. There may be substance in this claim if a comparison is made, say, between a small rural or urban district council and a large county borough. But in my paper I confined attention to the (autonomous) county boroughs only, and there the assertion cannot be supported. All county boroughs have their other departments fully developed. Even the smallest have their Treasurers, Engineers, Medical Officers, Surveyors, Architects, Education Officers, etc., and it is surely misleading to speak of the Medical Officer of Health, for example, of a large city performing duties undertaken by the Clerk in a small county borough.

Finally, even if the criticisms of my note had substance, I would point to the indefinite article in the title. It is important to devise and consider methods of deciding whether on administrative grounds at least the advantage lies with the larger unit or not. Most of the measures considered so far have been unsatisfactory for one reason or another. The ratio I proposed undoubtedly has shortcomings. But it is only by considering alternative measures and rejecting them when improvements are suggested that progress will be made. A careful reading of the above comment fails to disclose whether the writers think it worth while attempting to examine this question, or, if they do, what criterion they would adopt.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

International Air Transport Statistics

By A. M. Lester, M.A.*

Summary

International air transport statistics existed as far back as 1911, but were not organized until the International Commission for Air Navigation (CINA) started collecting and publishing statistics in 1932. The International Civil Aviation Organisation (ICAO) took over CINA's statistical functions after the War and these functions form an important part of ICAO's activities, since in the economic sphere it is predominantly a fact-finding Organization. ICAO's statistics cover over 90 per cent. of regular world air transport activity. The time-lag before ICAO can publish statistics relating to any particular period is considerable, but has improved and is still improving. Periodic meetings of experts from governments examine ICAO's statistical machinery and propose improvements. Standardization of statistical units and terms is being pressed forward, both in the United Nations and ICAO. Ton-kilometres and passenger-kilometers performed from the basis of air transport statistics. Ton-kilometres-available and seat-kilometres-available are important from the economic point of view. The distance dimension in these units is generally measured along the great circle from airport to airport, but exceptions are sometimes made where an air route regularly makes substantial detours. Scheduled air services form about 90 per cent. of world air transport. Exact statistics of non-scheduled air transport activity are not available. The distinction between international air services and internal domestic air services is important, since the former are regulated by international action and the latter are not. ICAO collects statistics of domestic air transport on an annual basis. The U.S. domestic airlines are larger than all other countries' airlines put together. ICAO has collected statistics relating to costs and revenues of airports and air navigation facilities on an *ad hoc* basis as part of the study of charges for these facilities. Airport movement statistics are sometimes used to supplement air transport statistics filed by airlines. An analysis of the origin and destination of passengers on international air services and of the flow of traffic along specific routes is requested for March and September each year in order to throw light on the way in which the world network of air services is developing. The analysis o fair craft speed records over the last 40 years indicates a remarkably steady increase which shows no sign of flattening out. ICAO has decided to study accidents in international air transport by means of statistical techniques, but it has not yet proved possible to make budgetary provision for this work. It would appear that air transport cruising speeds, which have increased steadily since air transport started, are likely to continue to increase.

History

1. Since air transport was a relatively late arrival among the world's economic activities, we have at least some statistics of its activities from its early days, which were indeed also the early days of the development of the science of statistics. The first substantial use of the air as a means of transportation was probably in 1870 during the siege of Paris, when communication was established between defenders in the city and those outside by means of free balloons carrying homing pigeons to provide a return service. Records were kept of this remarkable and successful enterprise, and it seems that some 4,000,000 letters and 88 passengers were delivered safely in the course of four months. We have statistics also of another interesting air transport project carried out with some success at a time which might be generally regarded as before the start of the air transport age. In 1911 and 1912 a German company operating airships designed by a certain Count Zeppelin carried 34,228 passengers between 8 German cities, flying 127,000 miles at an average speed of 25 miles an hour, no doubt learning, in the process, a good deal about how to operate such airships for less harmless purposes.

* Mr. Lester is Chief of the Economics Branch of the International Civil Aviation Organization. Any views expressed here are his own and not those of the Organization.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

2. Regular air transport services carrying passengers, freight and mail between different countries, or scheduled international air services as we now call them, started in Europe immediately after the First World War and soon developed in various parts of the world, taking advantage of experience gained with military aviation and with tentative air-mail experiments in the United States. Complete statistics for all these early international air services are somewhat hard to come by but the main ones have left good records, and it seems that shortage of civil aircraft and high initial fares, combined with some public distrust of the air as a medium of transportation, made for slow development in the first year. In 1919 the single air fare from London to Paris was 20 guineas, and aircraft on this service averaged only 1·53 passengers per trip. In 1920, however, French commercial air services carried 6,697 passengers, and in 1923 an arrangement to subsidize Imperial Airways was based upon an assumed mileage of 1,000,000 miles per year.

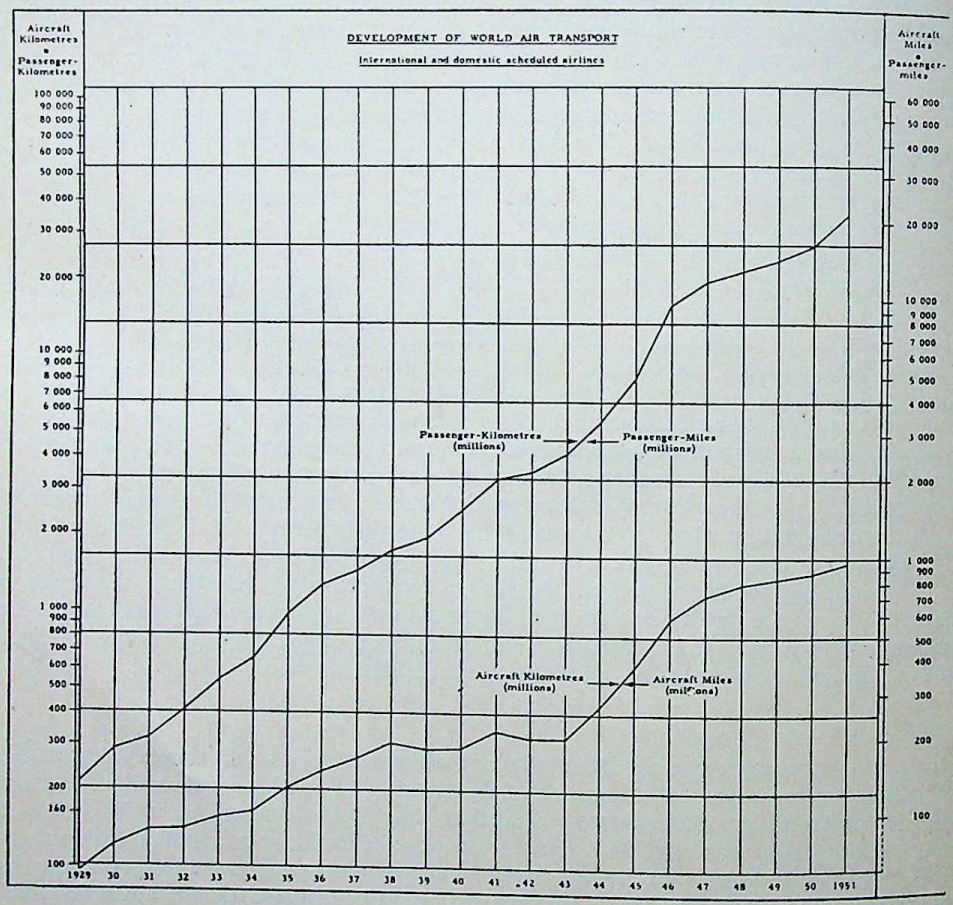


FIG. 1.

3. The development of international statistics received great stimulus from the League of Nations statistical activities, and the International Commission for Air Navigation, established in 1922 in Paris, had as one of its basic functions to "collect and communicate to Contracting States information of every kind concerning international air nagivation". This was a clear direction to collect and publish statistics of international air transport and the Commission after some years of study of what was practicable and desirable, began to collect statistics

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

from governments and to issue an annual statistical Bulletin, the first number appearing in 1932. An attempt was made to instruct Contracting States as to the nature of the statistics required, but each State tended to provide what it had available for its own purposes, and the resultant figures published in the Bulletin, although of the greatest value and interest, lacked standardization and comparability. Since 1921 the British Air Ministry had reviewed the development of foreign as well as of British air transport in its published reports on the progress of civil aviation (at first half-yearly and later yearly), and the statistics given in these reports, combined with the figures published by CINA for 1926 onwards, provide gradually improving data on the development of world air transport in its early days. The graph in Diagram I shows how rapid that development has been from 1929 to the present time. The total annual volume of traffic on the regular civil air services of the world, expressed in passenger-kilometres, has increased consistently each year for over two decades at a rate which resulted in the total doubling itself about every three years. The kilometres flown by the aircraft on these services did not increase so fast as the passenger-kilometres (the number of passengers per aircraft increased as the size of aircraft increased)* and was temporarily set back by World War II, but the total of passenger-kilometres increased even during that period and there seems to be little sign as yet of any flattening out of the graph.

Present Organization

4. When the Second World War ended, the statistical activities of CINA, which had been interrupted by hostilities, were taken up by the International Civil Aviation Organization whose headquarters were and are in Montreal. Statistics play a specially important part in the present organization of international air transport, throwing light on the legal and economic problems raised when airlines of one State operate over the territory of another, and forming as it were an alternative to world control by a centralized authority. When the organization of international air transport after the war was discussed at Chicago in 1944, it seemed doubtful whether air services could be permitted to develop and operate throughout the world without some central controlling authority with the power to decide which were necessary and which redundant, which constituted reasonable competition and which constituted excessive and uneconomic competition. It became clear, however, that such a controlling authority would not be generally acceptable to States at least for some years, on both economic and political grounds. The Chicago conference ultimately resolved this difficulty by deciding that the economic functions of the International Civil Aviation Organization should, at least at first, consist primarily of finding out the facts concerning the development of international air transport so that all States could be kept informed as to what was happening and could develop their national and international policies accordingly. The Convention on International Civil Aviation prepared at Chicago and now ratified by nearly 60 States therefore gave ICAO no controlling powers in the economic sphere, but incorporated specific clauses providing that facts and statistics relating to the operations of international airlines would be regularly filed with the Organization for study and publication. It is not infrequent for the free interchange and publication of statistics to serve this function of throwing light upon important activities as a prelude or alternative to some form of general agreement or plan, but it is seldom that the function is so deliberately and explicitly arranged.

5. In the Chicago Convention each Contracting State undertook that its international airlines would file with the Organization traffic reports, cost statistics and financial statements in accordance with requirements laid down by the Council, the permanent body of representatives of 21 Contracting States elected to carry on the day-to-day work of the Organization. The Council therefore directed its Air Transport Committee to work out a set of standardized statistical reporting forms which would indicate to Contracting States what statistics were required to be filed by them. After considerable study and experiment and a meeting of statistical experts from a number of Contracting States, eleven reporting forms were approved and issued in 1946, together with detailed instructions for completing them. These forms were derived largely from the statistical system developed by the Civil Areonautics Board in the United States, a system which was more advanced than that existing in most other States, and had been devised by the CAB with much

* The graphs being on a logarithmic scale the vertical distance between them conveniently measures the average number of passengers per aircraft.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the same fundamental purpose as that of ICAO in this field, namely, to enable the authorities concerned to keep a close watch on the development of air transport in all its aspects.

6. States began to file statistics on the new forms in 1947, and in November of that year ICAO was able to circulate a "Statistical Summary" containing 150 pages of traffic statistics relating to the activities of some 28 airlines in 14 different countries. ICAO statistical publications, referred to as Digests of Statistics, are now being issued at the rate of about eleven per year; two dealing with the simpler types of traffic statistics such as passenger and ton-kilometres performed by each airline, and the remaining nine with the more advanced analyses of airline organization and finance and the detailed way in which the traffic flows from place to place and country to country. The extent to which States file these statistics is perhaps surprising, considering that the Organization has no means of enforcing its requirements in this field, and that many States have no organization specializing in the compilation of air transport statistics. Although a number of States do not succeed in completing the statistical forms, the great majority of those with substantial airlines do. For the simpler type of statistics, the material filed each month now covers over 90 per cent. of regular world air transport activity. The more complex statistical forms are filed with less regularity, but even these cover about 60 per cent. of international air transport activity. There is still a considerable time-lag before ICAO is in possession of enough statistics for each month or year to be worth publication in detail and a still further time-lag before the more complex statistics are available, but some delay is inevitable in any statistical machinery of worldwide scope, and considerable improvement has already been effected. In the early days the great majority of statistics filed were already a year or more out of date before they reached ICAO, whereas at the present time nearly all the monthly forms are filed within six months of the month to which they relate and yearly forms are mostly filed within nine months. The statistical analyses and publications produced by the ICAO Secretariat from these figures are rapidly catching up with the early back-log.

7. The statistical machinery of ICAO is under constant review by the Air Transport Committee of the Council, which periodically convenes a meeting of statistical experts from all governments that can provide such experts. These meetings are regarded as sessions of a specialized "division" of the Committee with permanent functions, although the States and experts attending are generally different at each session. The governments thus have a method for examining the statistical machinery in this field at regular intervals and ensuring that it has exactly the scope and content that they require. The experts who attend the sessions of this Statistics Division are drawn from airline as well as government offices in the various States and include representatives of IATA.* It was hoped that the completion of the ICAO statistical reporting forms would not throw a great additional burden on the airlines or governments, since the forms were designed to contain statistics which most airlines and most governments would collect for their own purposes. It seems, however, that the original reporting forms, being based largely on the statistical procedures in the United States airlines and the United States Government, were not perfectly coordinated with statistical procedures in other airlines and governments, and it is hoped that future sessions of the Statistics Division will be attended by more statistical experts from Europe and elsewhere, and will be able to modify the forms so as to make them easier for non-American airlines to complete without spoiling their suitability for the American continent. The objective is to plan the ICAO statistical forms so that they constitute, in effect, part of the routine statistics filed by airlines with their governments, but since these naturally vary somewhat from country to country, the ICAO forms should include as many as possible of the common elements, and as few as possible of the elements that would be new and additional for many airlines.

Standardization and Comparability

8. The mere publication of eleven standardized air transport statistical reporting forms with instructions and definitions covering the main items to be reported has had a strong standardizing influence on the statistical practices of governments and airlines in the air transport field, and it

* IATA, the International Air Transport Association, is an association of airlines concerned with the airlines' interests. ICAO, the International Civil Aviation Organization, is one of the "Specialized Agencies" of the United Nations, an organization of States concerned with the governmental problems of international civil aviation.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

is noticeable that the air transport statistics published by the various countries of the world are now more standardized and more comparable than they were before these forms were circulated. There are, however, a number of ways in which airlines or countries follow non-standard statistical practices, and undoubtedly much remains to be done before international air transport statistics can be regarded as being soundly based on comparable and generally accepted terms and categories. This is particularly true in the financial field, where statistics are inevitably based on accounting practices which differ from airline to airline and country to country and sometimes from year to year. The problem is being tackled by representatives of the airlines under the aegis of the International Air Transport Association, and no doubt time will show a considerable improvement. The evolution of generally acceptable definitions for use in work in the international air transport field is inevitably slow, partly because of the differences in language and word usage, but perhaps even more because of the fundamental differences in organization and method of operation of air transport in different States and between States in different parts of the world. The definition of what should be regarded as constituting a scheduled air service in the international field has taken nearly five years of study by the States of ICAO. Different drafts of the definition proposed at various times would have resulted in many air transport enterprises being given substantially different economic rights of operation under the Convention, and would have made considerable differences to the total figures recorded for various categories of air transport. Even now the definition of this fundamental concept has only been approved for purposes of applying one particular article of the Convention, and it remains to be seen whether the same definition will be equally generally acceptable to the governments of the world for statistical purposes.

9. The Economic and Social Council of the United Nations has taken a special interest in the standardization of some of the more important terms and definitions for use in the various forms of transportation. A set of suggested terms and definitions was prepared by the Secretariat of the United Nations, and has been approved by the Economic and Social Council and issued as one of the United Nations "Statistical Papers" (Series M, No. 8). The following terms are tentatively defined for civil aviation statistics:

Cargo ton-kilometres performed	Kilometres flown
Mail ton-kilometres performed	Number of small passenger aircraft
Passenger-kilometres performed	Number of large passenger aircraft
Cargo loaded	Number of cargo aircraft
Cargo unloaded	

10. The Economic and Social Council recommends that statistics shall be compiled by each country at least for the totals in these nine series, and that the tentative definitions should be studied and tried out. This recommendation has not yet been examined in detail by the aviation departments of governments, and it is probable that they will have some difficulty with some of the proposed series. The collection of figures of cargo loaded and unloaded and of the number of cargo aircraft, for example, raise considerable difficulties of interpretation. Nevertheless, the publication of terms and definitions such as these, which are applicable with certain modifications to a number of different types of transportation, constitutes an important landmark in the progress of international statistics.

Units of Measurement

11. The basic unit of measurement in air transport is the ton-kilometre (or ton-mile), being the amount of transportation achieved when one ton of load of any sort is carried through one kilometre (or one mile). The long controversial question of the general adoption of the metric system for various forms of unit measurement has been raised again in an acute form by the widespread development of international airlines. Aircraft crews of many nationalities are forced in their daily work to exchange communications with many other nationalities on matters involving a variety of different meteorological and geographical measurements. In a matter such as this where human lives may depend upon the international adoption of standardized terms with no possibility of misinterpretation,* it might be thought that standardization would

* During World War II a number of lives were lost in aircraft accidents caused by confusion between the Imperial and the U.S. gallon, which resulted in pilots making incorrect assessments of their fuel supply and requirements.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

be quick and easy to achieve. All standardization, however, involves a change of practice somewhere and States find it even more difficult than private individuals to accept such changes, partly because of the size and complexity of the problem for a modern State, and partly because different groups of people in the same State often favour the adoption of different units. So far, governments have tackled the standardization of distance measurement only from the technical point of view, and the general agreement is that for the technical purposes of air navigation, horizontal distances shall be measured, not in metric units, but in nautical miles. Whatever its appeal to the navigator, this unit is not well adapted for use in other spheres, and the world as a whole is a long way from accepting the nautical mile for general use. In air transport statistics, for example, the expression "aircraft-nautical-mile" used to describe the distance flown by an aircraft would be puzzling if not self-contradictory, while the term "metric-ton-nautical-mile" would be extremely clumsy. For the present, therefore, ICAO publishes its statistics in kilometres and metric tons, but since a large part of the aviation world still finds the metric system difficult to work in, tables for general distribution are often published as well in miles and tons, the mile here having its ordinary land-lubber connotation of statute mile and the ton being the short ton of 2,000 pounds weight used in North America and now in many other countries, with no direct relationship to the volumetric "tons" used in shipping statistics.

12. Passengers provide about 75 per cent. of air transport traffic on most scheduled air services throughout the world, so that for many purposes statistics of passenger-kilometres (the sum of all passenger journeys) are a sufficient guide for the study of air transport activity. Passenger-kilometre statistics are generally used whenever a simple measure of air transport activity is required, as, for example, in assessing the need for air navigation facilities on a route or the payments for such facilities due from the governments of airlines using the route. Passenger-kilometres are also the best basis for comparing passenger fatalities in aircraft accidents. The contributions of member States to the financing of ICAO are related to the passenger-kilometres performed by the airlines of each State. All regular airlines record passenger-kilometres flown, and this figure is available for most airlines back to the early days of air transport, when cargo and mail traffic was often measured only by the number of pounds carried without reference to distance. The weight of a passenger and his accompanying baggage is recorded on aircraft load sheets before most flights in order to check that the total load and its distribution are acceptable from the safety point of view, but the fare paid by passengers being not dependent on weight, airline statistical records often do not show passenger traffic in terms of ton-kilometres. Passenger-kilometres are therefore generally converted into ton-kilometres, for assimilation with the ton-kilometres of cargo and mail traffic, by assuming a standard theoretical weight for a passenger and free baggage, often taken at the round figure of 200 lb. per passenger (giving 10 passengers to the short-ton) when quick approximations are required.

13. From the point of view of the economic planning of air transport, figures of the amount of transportation offered or made available are also extremely important, but are more difficult to obtain than figures of the quantity of transportation actually performed. This is partly because the ability of an aircraft to carry loads varies in some cases according to the length of the flight and is susceptible of several different measures for long flights involving stages of differing lengths, and partly because the amount of transportation offered is not, like the amount of transportation performed, an essential accounting figure which all airlines must record as part of their operating accounts. Statistics of capacity available* are normally expressed either in seat-kilometres-available or ton-kilometres-available, the latter figure including the maximum load of passengers, freight and mail. Comparison of these figures with passenger-kilometres and ton-kilometres actually performed produces what are generally referred to as the "passenger" and "over-all" load factors, normally expressed in percentage form. These two load factors may of course be different, since the passenger limit is determined by the number of seats, while the over-all load limit is decided by the maximum permissible take-off weight of the aircraft (or in some cases the maximum permissible landing weight) and the total weight that has to be lifted other than payload. Present passenger load factors on regular air services are mostly in the neighbourhood of 60 per cent. to 70 per cent., and it seems that in general it is not possible to operate air services

* The term "capacity" is used in the field of air transport to refer to the weight of useful or revenue load an aircraft, air service, etc., could carry, and has no volumetric connotation.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with average load factors much higher than this without causing inconvenience to passengers, in the form of infrequent services or the necessity of booking far ahead. Over-all load factors are in general somewhat lower than passenger load factors. A difference of two or three units in the load factor figure for an airline may mean the difference between a substantial loss and a satisfactory profit.

14. Table 1 gives some statistics of world scheduled air service activity (excluding USSR and China), showing some of the units most generally used to assess the trend of development. The more than twenty-fold increase in passenger-kilometres performed since 1937 reflects the

TABLE 1

Development of World Air Transport Services

International and Domestic Scheduled Airlines

Year	Kilometres Flown	Passengers Carried	Passenger-Kilometres	Cargo Ton-Kilometres	Mail Ton-Kilometres	Average Number of Passengers per Aircraft (number)	Average Distance Flown per Passenger (kilometres)
	Millions						
1937 . .	269	2·5	1,425	n.a.	n.a.	5·3	579
1947 . .	1,156	21·1	19,100	297	132	16·5	905
1948 . .	1,292	23·6	21,200	459	169	16·4	898
1949 . .	1,345	26·5	23,300	569	187	17·3	879
1950 . .	1,432	31·2	27,300	757	209	19·1	875
1951 . .	1,550	39·0	34,000	910	240	21·9	872

Conversions to Statute Miles and Short Ton-statute Miles

	Miles Flown	Passengers Carried	Passenger-Miles	Cargo Ton-Miles	Mail Ton-Miles	Average Number of Passengers per Aircraft (number)	Average Distance Flown per Passenger (miles)
	Millions						
1937 . .	167	2·5	885	n.a.	n.a.	5·3	360
1947 . .	718	21·1	11,868	203	90	16·5	562
1948 . .	803	23·6	13,173	314	116	16·4	558
1949 . .	836	26·5	14,478	390	128	17·3	546
1950 . .	890	31·2	16,963	518	143	19·1	544
1951 . .	963	39·0	21,127	623	164	21·9	542
	Increase or Decrease Between Years						
1947–48 .	+12%	+12%	+11%	+55%	+28%	—	−1%
1948–49 .	+4%	+12%	+10%	+24%	+11%	+6%	−2%
1949–50 .	+6%	+18%	+17%	+33%	+12%	+10%	−0·5%
1950–51 .	+8%	+25%	+25%	+20%	+15%	+15%	−0·3%
1937–51 .	+477%	+1,460%	+2,286%	n.a.	n.a.	+313%	+51%
1947–51 .	+34%	+85%	+78%	+206%	+82%	+33%	−4%

n.a. means not available.

Exclusions: USSR: all years.
China: 1949–1951.

ICAO Statistics Branch, June, 1952.

remarkably rapid and steady expansion of this type of transportation. If the figure of passenger-kilometres for 1951 is converted into ton-kilometres and added to the cargo and mail ton-kilometres performed, the result is an estimated total of 4,178 million ton-kilometres performed which, compared with an estimated 6,700 million ton-kilometres made available, gives an over-all load factor of 62 per cent. These scheduled air services of the world are operated by about 260 airline companies utilizing an estimated 3,860 aircraft and employing about 20,000 pilots and co-pilots. The present annual operating revenue of world scheduled air services is estimated at about $2,000 million.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

15. All the units of transportation performance which incorporate the concept of distance involve a number of problems of definition, many of which have not yet been satisfactorily solved as far as international statistics are concerned. It is not in fact at all clear exactly what is meant when it is said that a load has been carried a certain distance by air. The resultant displacement may fairly reasonably be measured by the great circle distance on the surface of the earth between the place of loading and the place of unloading, but this still leaves certain difficulties. In the first place, in the case of air travel, as in the case of rail travel, the places of loading and unloading are seldom close to the real origin and destination of the passenger or consignment of freight, and it is necessary to decide whether distances should be measured between airports or between some other agreed standardized points such as the centres of the cities or areas served; for short stages the difference can be as high as 10 per cent. A more complex problem is caused by the fact that aircraft do not necessarily follow even approximately the great circle course. One need not be concerned with minor or occasional deviations due to wind or weather, but there are a number of instances where the course regularly taken by scheduled air services between two airports departs widely from the great circle line owing to the physical necessity of avoiding mountains or prohibited areas. Then, again, where loads are transported long distances made up of a number of stage flights, the stages necessarily follow the pattern of airports on the route rather than the great circle between the first and last airports. The present general practice is to define the distance through which a load is carried as the sum of the great circle distances, from airport-to-airport, of the several stages of the journey, but on the routes where dog-leg courses are regularly flown for physical reasons some authorities measure distance along the course taken and others measure it along the great circle. The international airlines and the postal administrations in governments are endeavouring to obtain international acceptance for a set of standardized "distances" between the main airports of the world calculated for each pair of airports mainly on the basis of great circle distances, but taking into account a number of practical considerations as well.

16. Statistics of the number of passengers and the weight of cargo or mail "carried" by air transport services (without taking into account the distances travelled) do not provide a good measure of air transport performance, since the distance a passenger or a load is carried may vary from 30 miles to 10,000 miles. Moreover, there is the difficulty encountered in other forms of transport that a passenger may be "carried" several times during any period, perhaps by different airlines but on the same "journey". Even if the meaning of a "journey" can be defined, it is in practice difficult to ensure that passengers are not counted twice or more when they should be counted only once. The figures of passengers and other loads carried reported to ICAO are not entirely satisfactory from these points of view, and no doubt contain duplication which cannot be assessed. The figures can, nevertheless, be of some interest if their meaning is known approximately, and is consistent from year to year, since they give an indication of the length of journey travelled by passengers and other loads. It will be observed from Table 1 that the average distance flown per passenger on the scheduled air services of the world in 1947 was considerably higher than in 1937, a reminder that many of the world's long-distance air services, including those across the Atlantic and Pacific, are entirely post-war developments. The average distance flown per passenger is tending to fall slowly, of recent years, no doubt because the short-distance services have been expanding their traffic somewhat more rapidly than the long distance services.

Categories of Air Transport

17. One of the most important distinctions, from the legal and economic points of view, in present-day air transport operations, is that between "scheduled" and "non-scheduled" air services or between the regular public transport operations and all other air transport activities. The Chicago Convention, according to which the operating rights of international air transport are at present regulated, gave explicit recognition to the difference between these two broad categories, requiring scheduled international air services to obtain special permission to operate over foreign countries, but according a certain amount of freedom of operation without special permission to other international flights carrying commercial loads on charter or contract. The States of ICAO have, therefore, been particularly interested to achieve a standard definition of what is meant by a scheduled international air service, and to establish what are the other flights accorded rights in this part of the Convention. The Council of the Organization has recently adopted

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

such a definition after long and careful study of its implications, and this definition will now be tried out by governments in their own regulations and studied by the United Nations and other international bodies.

18. The collection of statistics of non-scheduled as distinct from scheduled air transport is perhaps even more difficult than the establishment of the legal and economic distinction between the two categories, owing to the fact that there are so many "non-scheduled" air transport operators doing such a variety of different types of transport jobs, from air taxi work to the transportation of perishable foods, ships' crews, livestock, machine spare parts, etc. Moreover, many non-scheduled air transport enterprises are small, and do not have the organization or facilities for keeping any but the most simple statistical records of their activities. Fortunately non-scheduled air transport is not so important a part of air transport as a whole as, for example, the analogous tramp activities are in the field of marine transport. At the present time it is estimated that all forms of non-scheduled commercial air transport represent no more than about 10 per cent. of total world commercial air transport activity. Many governments therefore do not collect statistics of the operations of the "non-scheduled" operators, and ICAO does not ask that such statistics should be filed for international purposes. There are, however, already signs that governments will need international statistics of non-scheduled air transport, both in order to watch its development under the rules laid down and in order to assess total air transport activity more accurately.

19. The distinction between international and internal or domestic air transport is also important to governments, since it is in general only with respect to international operations that the States have agreed to collaborate and the Convention of ICAO relates solely to international aviation. The drawing of a definite and accurate line between international and domestic operations is particularly difficult in air transport statistics owing to the way in which air services operate continuously and with the same aircraft across national territory and across frontiers. Many air services, such for example, as that between London and Manchester, are clearly enough purely internal and domestic to the particular country in which they lie; others, such as those across the Atlantic, are as clearly international in character, but between these extremes are many which could be regarded as partly domestic and partly international, and where it is difficult to draw a satisfactory line between the two categories. The Chicago Convention defines an international air service as one that passes through the air space over the territory of more than one State, but this does not help greatly from the statistical point of view, since there is no indication as to where an "air service" should be considered to start and stop, and whether, for example, the London to Prestwick stage of a London to New York flight should be counted as part of an international air service, or as a domestic operation on the grounds that it operates wholly within the United Kingdom. Fortunately for statistical purposes, although often unfortunately from the point of view of travellers by air, air services are at present to some extent defined and separated off from each other by the governmental licences and certificates under which they operate, so that it is possible to give statistics of "international" as distinct from "domestic" scheduled air services with the area of doubt, at least as to the official meaning of the terms, reduced to probably less than 2 or 3 per cent. ICAO collects statistics of domestic air services on an annual basis, and statistics of international and domestic air transport combined on a monthly basis for the UN Statistical Bulletin. Some countries' airlines operate almost entirely internationally as in the case of the Netherlands, Belgium and the United Kingdom. Other countries have domestic air services far larger than their international services, as in the case of the United States and Australia. The United States' domestic airlines perform more ton-kilometres of air transport than all the rest of the world's airlines put together (1,910 million ton-kilometres for the U.S. domestic airlines in 1951, against 1,717 million ton-kilometres for all other countries' domestic and international air services).

20. Other categories of air transport give little statistical difficulty at present. Airships, which at one time seemed likely to become the main form of long-distance air transport, appear for the present to have disappeared from the civilian picture entirely. Power-driven airships are still used for military purposes, but no regular civilian air transport is now carried out by means of lighter-than-air craft. Seaplane transportation appears to be disappearing in somewhat the same way, and although flying boats still operate on scheduled services in some parts of the world, and small aircraft on floats are much used for "bush" services in Canada and elswehere, it seems that for the foreseeable future their contribution to world air transport is likely to be confined to a limited number of special tasks. In some countries a distinction is made between "trunk"

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and "feeder" air services, but this distinction seems to be an arbitrary one and no attempt has yet been made to give it definition internationally.

Financial Statistics

21. Six of the ICAO air transport reporting forms are devoted to various types of financial statistics and a surprising quantity of data of this nature has been filed with the Organization. As anyone will appreciate who has studied accounting methods in different countries, the definitions of the various items of cost and revenue used by different international airlines are far from standard, and it is sometimes questioned whether any meaningful conclusions can be reached from statistics based on such widely different accounting methods. These statistics have, however, proved extremely valuable, notably in studies of what can be considered fair and reasonable rates for the carriage of international air mail and in examining charges for the provision of airports and ground aids to air navigation. IATA is studying how the accounting methods utilized by international airlines in different countries can be rendered more standardized and comparable.

22. Ground facilities form an important part of the economics of an air transport system, the capital invested in aerodromes being probably two or three times as great as that invested in the airlines themselves. International airports are at present financed partly by landing and other charges and partly out of public funds, municipal, provincial, or national. Airway navigation services (radio beacons, traffic control, communications, etc.) are mostly provided free by national authorities, but there is a growing tendency to charge the users for them or to throw the burden of providing them on to specialized organizations financed by the airlines. In order to study the desirability of such charges, ICAO has asked for and obtained a considerable volume of cost and revenue statistics relating to international airports and airway facilities, but these were provided on an *ad hoc* basis for a specific year and it is not at present intended to collect such statistics regularly. Statistics of scheduled air services and other aircraft "movements" at airports (a landing is a movement and a take-off is another movement) are collected by most governments, chiefly for planning the development of airports, but are not at present regularly filed with ICAO.

23. Some governments have endeavoured to compile the basic statistics of air transport within their territory from records of aircraft movements collected at airports. If a government obtains from the airports in its territory statistics of all commercial flight movements showing the previous stop for arrivals and the first subsequent stop for departures, together with details of the aircraft, its owner and the loads carried, the results can be integrated into a picture showing all the air transport activity within that territory and as far as the first landing outside. This method of obtaining statistics of air transport activity was, in the early days of air transport, much favoured by a number of countries, partly because their airports were governmentally operated and could be directed to file the necessary returns, whereas the airlines were often privately operated and less amenable to government instructions, and partly because the resultant statistics are in some ways more complete, since non-scheduled and foreign aircraft movements will be included as well as those of the scheduled air services. Few governments now obtain air transport statistics in this way, although many utilize airport movement statistics as a periodic or routine check on the activities of foreign airlines within their territories. The majority of governments compile their main statistics of air transport from returns filed by the airlines themselves, and the statistics filed with ICAO are nearly all prepared in this way. Airlines keep of necessity a considerable volume of statistical records, generally including in some form or another nearly everything that their governments and ICAO need, and although some airlines are not good at filing any statistics, the over-all picture obtained from airline records is far more complete than anything that could be obtained from airport records at the present time, since many airports have very small administrative staffs and are unable to produce reliable statistical records. Moreover most States have many more airports than airlines, so that the integrating of returns from airports is a larger statistical task than when airline returns are used. Nevertheless, some authorities believe that ultimately airport records could provide useful data concerning international civil aviation activity, and there is a considerable movement to obtain statistics of non-scheduled aviation in this way at the present time.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Origin and Destination of Passengers

24. It is of importance both to governments and airlines to be able to study the development of air traffic from country to country and place to place in some detail, and one method of analysis is to break down the figures of passenger transportation according to their origin and destination. Airlines are interested in such an analysis to assist them in planning their route patterns, frequencies and sales campaigns. Governments have this interest too, since all air services are operated under licences granted by the governments of the various countries served only after careful consideration of the public demand and competitive supply position. Governments have, however, a special interest in the origin and destination of international passengers, since the rights granted by States to foreign airlines to set down or take on loads in their territories are at present dependent upon the origin and destination of the loads in question, considerably greater freedom, for example, being granted by most States to a foreign airline wishing to take on loads destined for its own country than to one carrying loads to a third country.* Moreover there is a general desire on the part of governments and airlines to widen the operating rights of international airlines. At present these are settled by bilateral agreements between the governments of the airlines and the governments of the countries served, and the resulting multiplicity of agreements is complicated to apply and expensive to maintain. Practically all States would prefer a general multilateral agreement over these operating rights, but opinions differ as to what degree of freedom is economically necessary or desirable, and so far it has proved impossible to achieve such an agreement. One of the reasons therefore why governments wish to study the details of the development of international air services is to throw light on the economic requirements of these services, with the hope that a form of multilateral agreement can be devised which will satisfy all shades of opinion, and permit international air transport to develop in the way best calculated to serve the needs of the public.

25. To analyse all international air transport traffic statistics according to the origin and destination of the loads carried would be a heavy piece of statistical work, and the governments that have in the past collected such figures for their own purposes have asked for them generally only for specimen months of the year, and only with respect to passenger traffic where the ticket machinery can be used as a convenient basis for the analysis. ICAO has followed this practice, asking for statistics of the origin and destination of passengers on international air services only for March and September each year. These months are not of course a satisfactorily representative sample of the whole year, and it has been suggested that a more representative sample might be obtained by one of the established random sampling techniques, such as selecting one out of every ten tickets for analysis. The United States Interstate Commerce Commission successfully uses a one in ten sample of freight way-bills in this way to study railway traffic development. If such sampling could be carried out conscientiously throughout the year for airline passenger tickets, the result might well be better for some purposes than the present method of taking complete figures from two specified months, but air service traffic statistics are required to be broken down into small subdivisions where random sampling would be difficult, so that complete statistics for two separate months, even if not representative, may be more valuable than statistics from a random sample over the whole year. Moreover, the organization of many international airlines is not well adapted to the carrying out of a sampling procedure consistently from month to month throughout the year. For the present at least, the special collection of origin and destination statistics for two months of the years appears to be the best method of obtaining such figures without demanding complete 100 per cent. records and filing.

26. The analysis of these more detailed statistics of traffic brings one up against some of the more fundamental problems of transport statistics. All transport statistics are complicated by the fact that the act of transportation has not only a dimension of distance and a dimension of quantity, but also a specific position defined by its beginning and end. Origin and destination statistics are similar to import and export statistics in this respect, and can be analysed by arranging

* The terms "origin" and "destination" raise many difficulties of definition not yet resolved. They could for example refer to (1) the passengers' home and most distant place of stay on his trip; (2) the start and finish of that part of his journey done by air, or (3) the start and finish of his journey on a particular airline or air service. The concepts are further confused by passengers taking circular trips, making lengthy stop-overs en route, and sometimes purchasing separate tickets for different parts of their journeys.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

the figures in matrices as is sometimes done for import and export statistics. Where the information concerning origin and destination is related to airports or cities, the total number of possibilities becomes generally too great to show conveniently in the matrix form, and one is then forced into setting the statistics out in a series of tables showing all the journeys from each place of origin one by one. In ICAO the chief interest in origin and destination statistics is related to the countries of origin and destination rather than to specific airports or cities, so that in general the number of possibilities is not too great for the matrix method of presentation. This method also has the advantage of showing clearly the relationship between traffic with origin and destination in the home country of an airline (third and fourth freedom traffic as it is called in discussions of international operating rights) and traffic carried on journeys wholly outside the home country (fifth freedom traffic). Some of the larger airlines, however, now serve so many countries that a matrix showing even the countries of passenger origin and destination for a month becomes too large for convenient reproduction and study. Another of the basic problems in the detailed analysis of traffic statistics to which no satisfactory solution has yet been found stems from the fact that there are important economic and practical relationships between the traffic along adjacent routes or along two segments of the same route. It does not seem possible to express these relationships in a simple statistical form without the use of maps, or at least diagrams with geographical arrangement, and in any area where air routes form a developed network the diagrammatic presentation soon becomes too complex for the reader to be able to grasp its implications rapidly.

Aircraft Accident Statistics

27. The application of statistical techniques to the study of aircraft accidents is a highly specialized form of statistics within the general field of aviation statistics. In accident statistics the main difficulty is not the definition of terms and categories, but the establishment of what are the significant elements in the long and complicated history of a relatively few incidents. The first purpose of the statistical analysis of aircraft accidents is to indicate practical means by which their frequency or seriousness may be reduced. Accident statistics are also used in studies of national and international regulations concerning the liability of aircraft operators for injuries, deaths and damage resulting from accidents, in insurance studies, in planning fire-fighting and rescue services, and in devising methods by which accident investigations themselves can be made more effective.

28. Each accident is submitted to extremely thorough investigation, and the final report consists in effect of an exhaustive analysis of the events leading up to the accident. As a result of the report a number of different sorts of action may be taken aimed at preventing a recurrence of that particular type of accident. Technical efficiency and safety precautions have, however, progressed to the point where most of the detectable causes of accidents have already been eliminated so far as is economically practicable. It remains, therefore, for statistical analysis of groups of accidents and accident trends to indicate where existing standards of efficiency and safety should be regarded as being too high or too low in the light of the results, and to throw light on controversial points such as the value of backward facing seats in airliners, the ground clearance necessary in the proximity of airports, the number of consecutive hours flying that aircrew should be permitted to do, or the relative standards that should be required of non-scheduled as distinct from scheduled air service operators. In many cases statistical analysis is required to show whether a particular factor, such, for example, as poor visibility or pilot's fatigue, is a significant factor in accidents or not, a significant factor being defined as one whose elimination would have made the accident less probable or less serious. There are many hundreds of facts associated with every aircraft accident, some known with accuracy and certainty, such as the condition of the weather and the experience of the pilot, others that can only be guessed such as why a pilot lost control or what caused engine failure. The statistical analyst seldom has enough accidents of any one type to work on to make it possible to utilize the more advanced statistical techniques, but partial correlations are much used, and a variety of different sorts of accident "rate" provide methods for examining trends or making comparisons of the incidence of particular types of accident under different conditions. For most technical purposes the figure of fatal accidents per volume of aircraft kilometres flown is perhaps the most useful, a fatal accident being relatively

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

well defined as an incident involving one or more fatalities. For studying passenger safety records the figure of passenger fatalities per hundred million passenger miles or kilometres is widely used. For world scheduled air transport as a whole the figure of fatalities per hundred million passenger-kilometres has been falling steadily for many years and is now estimated to be less than one.

29. ICAO is in a specially advantageous position to develop the statistical analysis of aircraft accidents in so far as they affect air transport, for not only is ICAO the forum where the safety standards for world aviation are debated and determined, but it is also the only governmental authority with the wide scope and independence of national interests necessary to study the accidents of airlines of every nationality throughout the world. The meeting of aviation statistical experts held in ICAO in 1947 examined the whole subject in great detail, and recommended that it would be both practicable and desirable for ICAO to apply the techniques of statistical analysis to accidents occurring in international air transport. The Council accepted this recommendation, and machinery was set up to arrange that such accidents should be reported to ICAO. Up to the present it has not proved possible to make the budgetary provision necessary to carry out the statistical part of the work, but the accident reports are studied from the technical point of view, and much has been done to standardize and improve accident investigating methods throughout the world.

Statistics of Speed in Air Transport

30. Aircraft speeds in air transport are susceptible of statistical analysis in various ways. Statistics of aircraft hours flown and aircraft-kilometres flown combine to give average figures of airport-to-airport speeds for different routes, types of aircraft, length of stage, etc., taking account of incidental delays, regularity and reliability, and these figures can be compared with similar ones for other forms of transport. Speed is important to air transport partly for its own sake in that one of the major advantages of air transport over surface transport is the reduction in the time necessary to go from place to place or to send goods or correspondence from place to place. Speed is also important, however, as a factor affecting the cost of air transport. An aircraft can be regarded as a productive machine whose output is measured in ton-kilometres of transportation achieved per hour and the greater the speed the greater the output. As the speed of an aircraft rises the cost of further speed increments with the same type of aircraft and engine tends to rise even more rapidly owing to the increase of air resistance and other technical factors, but the progress of aircraft and engine design sometimes provides a possibility of substantial increases in speed without equivalent increases in cost as, for example, when aircraft with jet engines recently became available for civil air services. The average speed of air transport has in fact steadily increased since the first air service was inaugurated, while aircraft unit operating costs have fallen.

31. Complete statistics of air service speeds are not available for past years to provide a statistical picture of the trend, but it seems that there has been a fairly consistent relationship between air transport cruising speeds and the maximum speed achieved by the specially designed aircraft that set speed records, the cruising speeds of the newer and faster aircraft in use on regular air services being generally around one half the current maximum recorded speed. When, for example, the world speed record was at 294 miles per hour in 1932, new types of aircraft were becoming available for civil air transport with cruising speeds of about 150 miles per hour, while ten years later when the speed record was 470 miles per hour civil aircraft with cruising speeds over 200 miles per hour were being produced. Since 1948 no new world speed record has been officially approved by the Fédération Aéronautique Internationale which supervises such matters, but from published statements it seems clear that aircraft have frequently flown faster than sound, and it may be assumed that a speed record attempt to-day would, if unrestricted by military secrecy, produce a new figure of at least 800 miles per hour and possibly considerably more. The De Hâvilland Comet with a cruising speed of about 450 miles per hour may thus be considered as approximately following the general pattern. There is considerable interest, therefore, from the air transport point of view in Diagram II, which shows how aircraft speed records increased steadily between 1911 and 1948, and how smoothly a 1952 record of 800 miles per hour would continue the trend. Those who like making predictions of the future on the basis of extrapolations from trend graphs will be interested to see from the graph that the upward trend of maximum aircraft speeds is showing little sign of flattening out. The steadiness of the rise in maximum

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

speed over the entire 40-year history of power-driven aircraft, and the fact that the speeds of the new jet aircraft do not appear to be far out of the long period trend, suggest that further development in the speed of air transport is likely also to be steady rather than spectacular. Even so the progress from Count Zeppelin's 25 miles per hour service in 1911 is considerable, and it is interesting to note that this progress, which is largely dependent on technical improvements in the design of aircraft, has taken place rather more in years of peace than in years of war. The aeroplane is given much attention in wartime, but its development for peaceful purposes does not seem to be as dependent on that attention as is sometimes maintained.

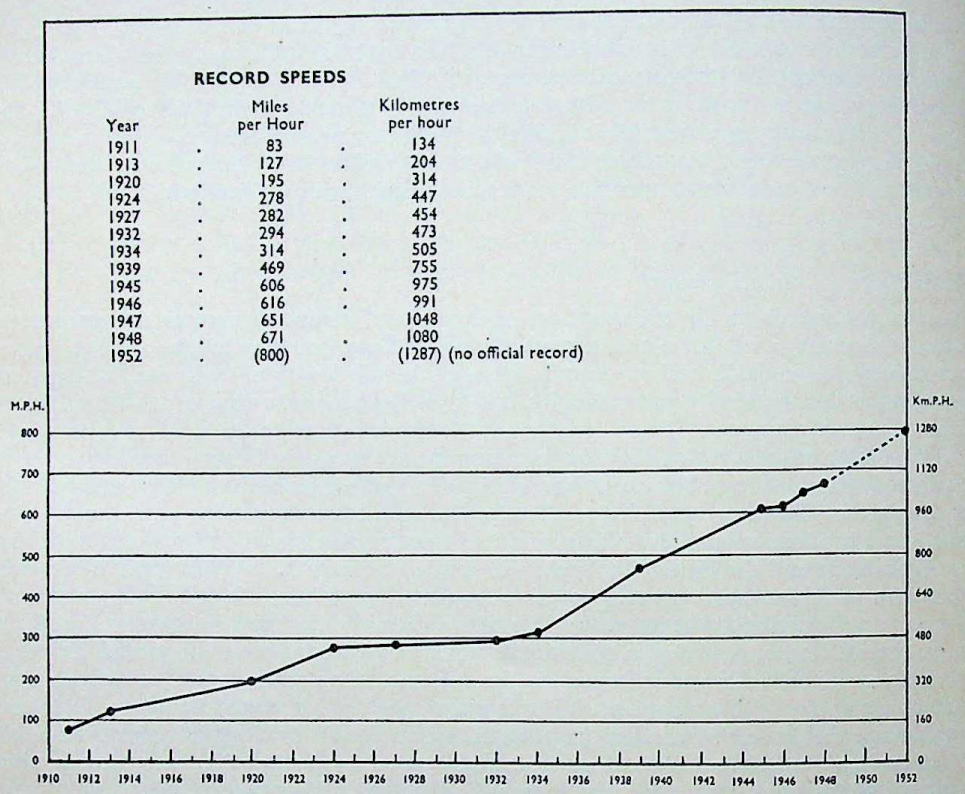


FIG. 2.—Trend of aeroplane speed records 1911 to 1948.

32. It is also interesting to note that the technique of statistics may reasonably be said to have kept pace with the progress of aviation and the development of air transport. We probably have better statistics for the 1,500 million kilometres flown in 1951 by hundreds of regular air services of fifty odd nationalities all over the world than were kept for the local airship service in Germany in 1912. Moreover, international air transport statistics do not stand alone in the world economic picture. They now form part of a statistical framework developed and co-ordinated by the United Nations and its Specialized Agencies, which enables world economic planning to proceed with considerable and increasing success on a basis of facts and study and hard work while the political figures in the international limelight are locked in debate. Statistics is one of the least spectacular of the activities of international organizations, but perhaps for that very reason its progress is steady and sound.

Bibliography

International air transport statistics have not as yet acquired a large bibliography. The most useful reference material is contained in the statistical publications of ICAO, the United Nations and certain national governments. The League of Nations and CINA provided some data in the past. The main sources of information are:

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

(1) ICAO Statistical Digests published approximately monthly containing different types of data;

(2) various official statistical papers issued by ICAO including the reports of the Statistics Division;

(3) U.N. Statistical Bulletins published annually and various U.N. Statistical papers.

Amongst governmental publications those issued by the Civil Aeronautics Board and the Civil Aeronautics Administration in the U.S. are the most complete and detailed. A quantity of useful statistical and other data relating to international air transport will be found in the frequent reports and studies published by IFTA (Institut Français du Transport Aérien), 4, rue de Solférino, Paris 7ème, France.

Postscript

Since the above article went to press a Second Session of the Statistics Division of the Air Transport Committee of ICAO was held in Montreal attended by representatives from fifteen contracting States of ICAO. The Final Report (DOC 7330, STA/528) of this meeting can be obtained from H.M. Stationery Office. It does not propose any radical change in the Organization's statistical machinery, but suggests a number of reductions in the statistics requested with the object of reducing costs to airlines and governments. The statistics of the origin and destination of passengers were much criticized as being incomplete and misleading, and it was recommended that their collection should be discontinued while their meaning and value and the cost of collecting them are studied.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Sources and Nature of Statistical Information in Special Fields of Statistics

Statistics Relating to the Use of Land in the United Kingdom

This note on statistics on the use of land was prepared by the Central Statistical Office in consultation with the Departments concerned. It describes in detail the nature of the statistics on land use available in Government Departments, and the documents in which the information is to be found. The note was prepared in the first instance for official use, and it is included in the present series, at the suggestion of the Inter-Departmental Committee for Social and Economic Research, in the hope that it may be of wider interest.

Much of the information described is published; some of the unpublished information can be supplied by Departments to research workers on request. No information can, however be disclosed which might be identified as relating to any particular individual.

The following pages describe the information available at the time of writing (January, 1953), and the information may be affected from time to time by changes in legislation. Since the object of this note has been to describe not only the nature of the statistics but also the sources and methods of collection, it was found convenient to arrange the description, not by subjects, but by the responsible authorities, as follows:

I. Agriculture Departments.
(Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland, and Ministry of Agriculture (Northern Ireland).)
II. Forestry Commission.
III. Ministry of Housing and Local Government and Department of Health for Scotland.
IV. Central Land Board.
V. Board of Inland Revenue.
VI. Ordnance Survey Office.
VII. Ministry of Transport.

I. Agriculture Departments

1. The statistics of land use collected by the Ministry of Agriculture and Fisheries under the Agriculture Act, 1947, relate only to land used for growing crops and grass. They are collected primarily for the purpose of estimating the quantities of various crops harvested and the amount of land used for grazing livestock.

2. The information available relates therefore to the areas of land under different types of crops and grass. It is obtained mainly from answers to two types of returns circulated by the Agriculture Departments—the quarterly agricultural return taken by all three Departments, and the supplementary half-yearly glasshouse return taken in England and Wales alone. Of these two returns, the former is by far the more important.

3. *Quarterly agricultural return.*—The quarterly agricultural returns for England and Wales are collected by the Ministry of Agriculture and Fisheries in March, June, September and December, but as from March, 1953, the censuses for quarters other than June are being collected on the basis of a sample of one-third of the agricultural holdings. The June return will continue to be collected from all holdings. The return is usually made on the 4th of the month, but when the 4th is a Saturday or Sunday it relates to the previous Friday. The June return contains more information on land use than the other quarterly returns as it covers all land used for growing crops and grass, which in June, 1952, amounted to 24,492,000 acres, while the three other returns ask for information about the areas of land under a few special crops only. The June return is submitted to the District Offices of the National Agricultural Advisory Service and is made with respect to "all land used for growing food or feed for any livestock (including grazing land), as well as flowers and nursery stock for sale, and crops such as hops and flax". Specifically excluded

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

from the return, however, are "private flower gardens, shrubberies, lawns, woodlands, osiers and willows and land under buildings, roads, yards, ponds, quarries and the like". For some of these categories the Minister has no statutory power to collect information; nor has he the power to find out the total area of the holding. The return is made under about thirty-five headings for crops and grass, of which the principal crops in June, 1952, were wheat with 1,963,000 acres, barley with 2,076,000 acres, oats with 1,676,000 acres, mixed corn with 827,000 acres and potatoes with 682,000 acres. The return includes about thirty headings for vegetables and flowers (including crops grown in glasshouses and frames) amounting to about 435,000 acres, and about six headings for small fruit. The areas under each of these headings are required to be given to the nearest quarter of an acre. The headings include special provision for land lying fallow, land under crops not specifically mentioned, small patches of crops less than one-quarter of an acre in area, and fruit and vegetables not grown primarily for sale. The heading "rough grazings" includes mountain, heath, moor and down land used for grazings, but common grazings are not returned by individuals. In England and Wales estimates of the area of common grazing lands are made separately for each parish by local officers of the Ministry of Agriculture and Fisheries in England and Wales. These estimates are not as reliable as the occupiers' returns, since frequently there is considerable doubt about which land is "common" and which land belongs to particular holdings. The June, 1952, figures were 3,890,000 acres of rough grazing land in sole occupation and 1,504,000 acres of common rough grazing.

4. The Ministry of Agriculture and Fisheries aim at getting a return from every agricultural holding in England and Wales which is run as a separate unit and has an area of more than one acre. The definition of "agriculture" in this context relates to the use of land and not the principal occupation of the person in charge: it is therefore more comprehensive than what is ordinarily thought of as farming.

5. In Scotland the agricultural returns are collected by the Department of Agriculture for Scotland. These returns also are made for all holdings over one acre in extent, and are submitted direct by the occupiers of the land to the Department's Statistics Branch ; there are no intermediary local officers to estimate acreages or to follow up cases of belated submission as in England and Wales. When the 4th of the quarter month is a Sunday censuses are taken on the 3rd. The material collected is broadly similar to that collected in England and Wales, but in the cases of some horticultural crops less detail is requested. From time to time questions concerning glasshouse cropping are included in the questionnaires. The total area of crops and grass returned by occupiers in Scotland in June, 1952, was 4,391,000 acres, of which 903,000 acres were under oats. The combined area of rough grazing land in sole occupation and common land was 10,980,000 acres, which includes land in deer forests used, or capable of being used, for grazing.

6. In Northern Ireland returns are collected by the Ministry of Agriculture (Northern Ireland); the June returns are substantially the same as those for England and Wales, except that they are made for all holdings of one-quarter of an acre or more. The area of crops and grass returned by occupiers in June, 1952, was 2,279,000 acres, the main crops being oats (302,000 acres), potatoes (137,000 acres) and flax (23,000 acres).

7. The occupier of a holding is legally bound to make a return if asked to do so, but if no questionnaire is sent to cover a particular holding, then the occupier has no legal responsibility for making a return. There are at present approximately 380,000 holdings in England and Wales from which returns are collected. Changes of area or identity occur in something like one-fifth of these holdings each year, and because of the difficulty of following up all these changes without delaying the summarization of the returns, it is obvious that some agricultural land will escape enumeration for a time. However, the chief purpose for which these statistics are collected is the estimation of the production of the "national farm", for which purpose the resulting error is too small to be important. But in using these statistics for other purposes the error may be much more important. Under present conditions, with rationing of feeding-stuffs and payments of certain subsidies, it can safely be assumed that all important agricultural holdings make returns. This, however, was not always the case, and the introduction of various rationing schemes and subsidy payments during the war disclosed many holdings (mainly small poultry holdings) of which the Ministry of Agriculture had no previous record.

8. The circumstances are broadly similar in Scotland, where there are approximately 78,000 holdings (including common grazing) and roughly 200 deer forests. In Northern Ireland in

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

June, 1952, there were about 83,000 holdings over one acre ; of these, about 60 per cent. were 30 acres or under in area, and about 78 per cent. were 50 acres or under. From 1953 onwards the returns will be collected in Scotland in June and December only ; and in Northern Ireland only in June and January, the March and September censuses being discontinued.

9. *Glasshouse return.*—The glasshouse return is a supplementary return made in January and July each year in England and Wales only, and covers not only occupiers of more than one acre of agricultural land but also occupiers of smaller areas. The total area of agricultural land under glass on holdings exceeding one acre can be determined from the June agricultural returns, and the purpose of these supplementary returns is to obtain particulars also of smaller holdings having 1,000 square feet or more of glass, and to give in more detail the area of various crops grown under glass, the area occupied by glasshouses, frames, etc., and to show how much of the glasshouse area is equipped with heating apparatus. The area of glasshouses returned in July, 1952, was 4,619 acres, of which 3,918 acres were equipped with heating apparatus.

10. *Annual changes in area.*—The Ministry of Agriculture and Fisheries also use the June returns to estimate the amount of land gained or lost by agriculture in England and Wales during the year. This is a formidable undertaking, which involves comparing, for every holding, the current acreage with the acreage returned in the previous year. Each year the areas of about 80,000 holdings are found, for one reason or another, to have changed during the year. It is, of course, impossible to check completely the reasons for all these changes, but the local officers of the Ministry ascertain as far as possible the reason for the changes in the areas returned. The results of these investigations are summarized by the Ministry to show the gains and losses of agricultural land, analysed under some seven or eight headings. The figures have several drawbacks, of which the most important are as follows :

11. First, the statistics have as their main object the estimation of crop and livestock production; to account for the total agricultural area is only a secondary purpose. Thus the statistics have not hitherto extended to estimating that part of the area of the agricultural holdings which consists neither of arable crops nor of permanent grass and rough grazing land, that is to say, they do not cover the area of copses, spinneys and shelter belts; of land occupied by farmhouses and farm buildings; that under farm roads and yards; ponds; the occupier's flower garden or lawns; patches of land not used for any agricultural purposes. For some of these items statistical inquiries from occupiers would not be covered by existing statutory powers, which relate to land "used for agriculture" in a strict legal sense.

12. Secondly, the statistics of acreages have not, during the past fifty years, covered pieces of agricultural land of one acre or less.

13. Thirdly, they do not cover land which for one reason or another is not at the time known to the officer collecting the returns to be used for agricultural purposes, though this area is believed to be much smaller now than formerly.

14. There is no reason to think that the inclusion of the excluded areas would have any appreciable effect on the Ministry's estimate of crop or livestock production, but when the figures are used to measure annual changes in the total agricultural area these matters are important, for the areas excluded may fluctuate considerably from year to year. The year-to-year changes in total area recorded by the Ministry's return can therefore be taken only as a very rough guide to the net annual loss of agricultural land, and on occasion may even be misleading. For instance, in 1941 feeding-stuffs rationing was introduced, and many persons who were not rendering returns because they were not on the collectors' list found it desirable to have the omission rectified. This resulted in the addition to the returns of 1940–41 of some 250,000 acres, thus masking the true change in the area of agricultural land and, in fact, converting a probable loss into an apparent gain. (See "Losses and gains of agricultural land in England and Wales", *Agriculture*, August, 1949, 56, No. 5.)

II. Forestry Commission

15. Statistics relating to the use of land by the State for forestry purposes are given in the Annual Reports of the Forestry Commissioners (available from H.M.S.O.). These reports provide annual statements of the extent of plantations in the charge of the Forestry Commissioners, the acreage of land held for afforestation in due course, etc. This information, along with details

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of the plantations made annually, is given separately for England, Scotland and Wales. Information is also given on certain aspects of private forestry.

16. A census of woodlands, both private and State in Great Britain was undertaken by the Forestry Commission in 1947–1949. A summary of the results of this census has been published in *Forest Record No.* 3, *Census of Woodlands* 1947–1949 *Summary Report* (H.M.S.O.). This report relates to all woodlands in blocks of five acres and over ; it gives details for England, Scotland and Wales, under the following main heads:

(*a*) Area of Woodlands:

Under this head is given a summary classification of woodlands by type, a classification of High Forest by age classes and composition (i.e., coniferous or broadleaved), and analysis of High Forest by major tree species, and an analysis of suitability for economic management.

(*b*) Volume of High Forest and of Standards in Coppice-with-Standards:

This consists of an estimate of volume of standing timber by principal types of woodland.

(*c*) Volume Increment of High Forest and Standards in Coppice-with-Standards:

This comprises, first, an estimate of current annual volume increment with details of coniferous and broadleaved categories, and secondly an estimate of current annual volume increment with details by age classes and types of woodland for Great Britain as a whole.

17. Two points in particular should be noted in using the material obtained from the Census:

(i) The acreage and condition of the woodlands were obtained by a physical survey and thus have a high degree of accuracy. But as fellings, replanting and afforestation are going on all the time the present position of the woodlands will differ from that given in the several census reports.

(ii) The volume assessment is based on measured plots selected according to a random sampling method. The calculation of sampling errors showed that while the estimate gives a reasonably accurate estimate of the volume of timber in the woodlands of Great Britain as a whole, figures for individual categories in parts of England, Scotland or Wales are much less precise.

18. The Census of 1947–1949 was supplemented by additional surveys in 1951, and the combined results are being published in a series of five Census Reports, details of which are given below. The first of these was published in January, 1953, the others will follow in the course of the year.

19. *Census Report No.* 1, *Census of Woodlands* 1947–1949, *Woods of Five Acres and Over*, amplifies the information given in *Forest Record No.* 3 (described above), and gives summaries by counties. Detailed figures for counties are to be published in *Census Reports Nos.* 3, 4 *and* 5 (see below).

20. *In Census Report No.* 2, *Census of Woodlands* 1951, *Hedgerow and Park Timber and Woods Under Five Acres*, information under the heads given below is presented for England, Scotland, and Wales, and Great Britain as a whole, but not for separate counties.

(i) The area and classification by type, species and age-class of small woods between one and five acres in extent.

(ii) The volume, and annual volume increment of woods one to five acres in extent.

(iii) The volume and annual volume increment of scattered trees in hedgerows, parks and woods under one acre in extent.

(iv) The volume, and annual volume increment of trees of timber size standing on certain types of woodlands of five acres and over discussed in *Census Report No.* 1, namely, simple coppice, scrub, devastated and felled woodlands.

21. The three reports listed below extend to individual counties most of the information given for the separate countries in *Forest Record No.* 3 and *Census Report No.* 1:

Census Report No. 3, *Census of Woodlands*, 1947–1949, *Welsh County Details.*
Census Report No. 4, *Census of Woodlands*, 1947–1949, *Scottish County Details.*
Census Report No. 5, *Census of Woodlands*, 1947–1949, *English County Details.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

III. Ministry of Housing and Local Government and Department of Health For Scotland

22. The Ministry of Housing and Local Government and the Department of Health for Scotland have no comprehensive statistics of land use at present. However, under the Town and Country Planning Act of 1947, local planning authorities, i.e., the councils of counties and county boroughs in England and Wales and the councils of counties and large burghs (and two small burghs) in Scotland have firstly to carry out a survey of their areas and secondly to submit, for the approval of the Minister and the Secretary of State for Scotland respectively, development plans, showing their proposals for the future use of land in their areas, accompanied by a survey map, or maps, showing existing land uses. In England and Wales the land use survey is based on the recommendations of *Circular No.* 63; in Scotland the survey is analysed on a map based on *Broadsheet No.* 14 of the Department's Technical Broadsheets. It is possible, therefore, that during the next two or three years useful information about land uses in most areas will become available from these sources.

23. The survey maps for counties (other than town areas, i.e., areas for which town maps are prepared) will generally be on a scale of 1 in. to the mile, so that the measurement of acreage will be difficult. The maps for county boroughs and town areas in England and Wales and for town areas generally in Scotland will normally be on a scale of 6 in. to the mile, and from these it should be possible to measure and classify the uses of land that are shown with some degree of accuracy.

24. Local planning authorities may also supply tabulated statistics of land use with their Development Plans but they have no obligation to do so. In England and Wales such statistics would normally follow the classification recommended in *Circular No.* 63: in Scotland they would probably be based on the similar classification in *Broadsheet No.* 14. The statistics may, however, be presented in other ways, and may not therefore be strictly comparable as between one authority, or area, and another.

IV. Central Land Board

25. The main information on land use provided to the Central Land Board comes from the claims for payment in respect of depreciation of land values under Part VI of the Town and Country Planning Act, 1947 (Part V of the Scottish Act). A secondary source of information, which has recently lost most of its significance, is provided by the applications to the Board to determine development charges under Part VII of the Act (Part VI of the Scottish Act).

26. The financial provisions of the Act, which came into force on July 1st, 1948, were intended to solve the compensation-betterment problems of town and country planning. The development value of land is the difference between its value if restricted to its current existing use, and the value it would have in the open market because of its suitability for some more valuable use. Under the Act it was proposed to distribute £300 million to those who could prove that their land had development value on July 1st, 1948, and on the other hand to collect a development charge from an owner who developed his land, thereby realizing its development value. The Town and Country Planning Bill, 1952, introduced on November 18th, 1952, proposes to abolish the development charge and to alter very materially the situation as regards the payments for loss of development value. The proposal is that the £300 million should not be distributed, but that certain claims should be paid under a future Act of Parliament. A White Paper (Cmd. 8699) indicates the Government's intentions in more detail.

27. Some 940,000 claims under the 1947 Act (including 137,000 in Scotland) were submitted to the Board. The claim forms relate only to land whose value was considered by the owner to be affected by the 1947 Act and to have development value, and claims may not have been made for all land thus affected. The bulk of claims have been analysed both according to the development status of the land on July 1st, 1948, and according to the type of claimant. These analyses are available for Great Britain as a whole, and for Scotland, Wales and the regions of England separately. Information on individual claims lodged with the Board is confidential.

28. As regards applications to the Board to determine development charges, some 390,000 were submitted between July 1st, 1948, and the date of the introduction of the 1952 Bill, and a summary of some of the information abstracted from the applications is published in the Board's Annual Reports. Individual application forms are regarded as confidential. The Board's consent to proceed with development was not given unless either the development was exempt from development charge, or the charge had been paid or secured. It is thus possible in theory

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

to obtain information concerning most changes in land use during the period when there was a liability to development charge. Up to November, 1952, the applications were analysed according to the type of property to which they referred, and these figures were further classified according to the kind of developer making the application. The statistics concerning development charge paid (which are also published in the Board's Annual Reports) were analysed according to the type of property on which the charge was paid.

V. Board of Inland Revenue

29. As from February 1st, 1950, the Valuation Office of the Inland Revenue took over from Local Authorities in England and Wales (but not in Scotland) the work of valuation for rating. The Valuation Office now prepares the valuation lists which are kept at the offices of the various rating authorities. Certain properties are excluded from these lists (e.g., agricultural land, railway property and land occupied by the British Electricity Authority). In conjunction with the forthcoming revaluation an analysis of all rated hereditaments will be made and will be published in due course in one of the Annual Reports of the Commissioners of Inland Revenue. This analysis will show the numbers of hereditaments in each class of user, e.g., factories, schools, shops, houses.

30. Certain statistics having some bearing on land use are published in the *Annual Reports of the Commissioners of Inland Revenue*. The statistics include (*a*) income tax statistics giving information concerning the Schedule A annual value of houses and property and concerning the profits under Schedule D of certain trade groups using land (e.g., agriculture and horticulture), and (*b*) statistics of death duties giving information concerning the capital value of real and leasehold property which passed on death, analysed into various classes such as land; building; mines, minerals and quarries; timber; and sporting rights.

VI. Ordnance Survey Office

31. Since 1925 the areas of all parcels of land which are shown on Ordnance Survey 1/2,500 scale plans have been abstracted under the following ten headings:

Inland water.
Roads and railways.
Towns and villages.
Woods and forests.
Public parks and recreation grounds.
Private parks and recreation grounds.
Marsh, fresh and salt.
Foreshore and tidal water.
Mountain heath and moorland.
Other land.

Only those plans which have been revised since 1925 were so abstracted, the only complete county being Middlesex. The abstracts have never been published, but were retained in Ordnance Survey records, and are available on demand. Many were destroyed during the war, and there now remain records of plans covering only about one-tenth of the country. These, apart from Middlesex, are widely scattered and could not be used to obtain a reliable picture of land use.

32. The practice of abstracting into the above categories has now been discontinued. No reliable comparative statistics on land use are therefore obtained from the Ordnance Survey.

VII. Ministry of Transport

33. The only statistics on the use of land available in the Ministry of Transport relate to the length (in miles) of public roads and of railways in Great Britain. The figures relating to roads are published in the *Annual Abstract of Statistics* and in the *Road Fund Report*, and are analysed under headings of various types of roads. The area covered by such roads is not, however, available, and there are no figures concerning private roads. The figures of track miles of railways, and of the length of permanent way including sidings, can be found in the *British Transport Commission's Annual Reports*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Bibliography

I. *Agriculture Departments*

Statistics of land used for agricultural purposes are periodically given in the national and farming press and are regularly published in the following:

Monthly Digest of Statistics, giving totals of crops, etc., for the United Kingdom for 4 years, with figures for 1939, published by the Central Statistical Office.

Annual Abstract of Statistics, giving totals of crops, etc., for the United Kingdom for 10 years, with figures for 1938, published by the Central Statistical Office.

Agricultural Statistics, Part I, United Kingdom, gives details of the acreage of crops, etc., in the United Kingdom, with separate figures for England and Wales, Scotland, Great Britain and Northern Ireland. Published by H.M.S.O.

Agricultural Statistics, Part I, England and Wales, gives details of the acreage of crops, etc., in each county of England and Wales with totals for England, Wales and England and Wales. Published by H.M.S.O.

Agricultural Statistics, Part I, Scotland, gives details of the acreage of crops, etc., in each county of Scotland, with totals for England and Wales, Great Britain, Northern Ireland and the United Kingdom. Published by H.M.S.O.

II. *Forestry Commission*

Annual Reports of the Forestry Commissioners. (H.M.S.O.)

Forest Record No. 3, *Census of Woodlands* 1947–1949*: Summary Report.* (H.M.S.O.)

Census Report No. 1, *Census of Woodlands* 1947–1949*: Woods of Five Acres and Over.* (H.M.S.O.)

* *Census Report No.* 2, *Census of Woodlands*, 1951*: Hedgerow and Park Timber and Woods Under Five Acres.* (H.M.S.O.)

* *Census Report No.* 3, *Census of Woodlands*, 1947–1949*: Welsh County Details.* (H.M.S.O.)

* *Census Report No.* 4, *Census of Woodlands*, 1947–1949*: Scottish County Details.* (H.M.S.O.)

* *Census Report No.* 5, *Census of Woodlands*, 1947–1949*: English County Details.* (H.M.S.O.)

* To be published during 1953.

IV. *Central Land Board*

Report of the Central Land Board to March,				1949.	(H.C. 223, 1949.)
,,	,,	,,	,,	1949–1950.	(H.C. 148, 1950.)
,,	,,	,,	,,	1950–1951.	(H.C. 258, 1951.)
,,	,,	,,	,,	1951–1952.	(H.C. 242, 1952.)

V. *Board of Inland Revenue*

Annual Reports of the Commissioners of Inland Revenue. (H.M.S.O.)

VII. *Ministry of Transport*

Annual Abstract of Statistics. (Central Statistical Office.)

Road Fund Report. (H.M.S.O.)

Annual Reports of the British Transport Commission. (H.M.S.O.)

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REPORT OF THE COUNCIL

For the FINANCIAL YEAR *ended December 31st, 1952, and for the* SESSIONAL YEAR *ended June 24th, 1953, presented at the* ONE HUNDRED AND NINETEENTH ANNUAL GENERAL MEETING *of the* ROYAL STATISTICAL SOCIETY, *held at the London School of Hygiene and Tropical Medicine, W.C.1, on June 24th, 1953.*

The Patronage of Her Majesty the Queen

IN the loyal address of condolence sent to Her Majesty Queen Elizabeth II on the death of King George VI, the hope was expressed that the Society might continue to merit and receive Her Majesty's gracious patronage. It was with much satisfaction that the Council learned from the Keeper of the Privy Purse that Her Majesty has consented to extend Her patronage to the Society. This advice was received too late to be included in the Annual Report for the Session 1951–1952, although it was communicated to Fellows in the course of the proceedings of the last Annual General Meeting. The Council wishes to place on record its great pleasure in continuing to receive this evidence of Royal favour.

On the occasion of the death of Her Majesty Queen Mary, a telegram in the following terms was sent to the Society's Patron:—

> To Her Majesty Queen Elizabeth II:
>
> The President, Council and other Fellows of the Royal Statistical Society with their humble duty offer to your Majesty their sincere condolences on the death of Her Majesty Queen Mary. They express the hope that Your Majesty and other members of the Royal Family will be sustained in the sorrow which is shared by all Fellows of the Society.

The following gracious acknowledgment was received:—

> The Queen desires me to express Her sincere thanks to you and all who join with you in your kind message of sympathy. (Private Secretary.)

Number of Fellows

The number of Fellows at December 31st, 1952, was 2,424, the highest number in the history of the Society and 117 in excess of the previous record reached in 1951. During the year 221 Fellows were elected or restored to the roll and 104 were lost. The additions were slightly fewer than in the previous two years (222 and 228). Losses were also smaller than in 1951 when, it will be remembered, 15 life subscribers whose addresses had been unknown for at least five years were removed from the roll. The corresponding number removed in 1952 was only 2.

A further slight increase in the number of Fellows took place in the early months of 1953 and at the end of April the total stood at 2,430.

The number of Honorary Fellows at December 31st, 1952, was unchanged at 14, and these, as in 1951, included 7 Presidents for the time being of other Societies concerned with the advancement of statistical knowledge. The figure of 2,424 ordinary Fellows at the same date includes 107 representing corporate bodies or institutions.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Calendar Year	*Number of Fellows (excluding Honorary Fellows)* Lost by Death, Withdrawal or Default	Elected, or Restored to the Roll	On the Roll at December 31*st*
1941	65	60	1,074
1942	69	74	1,079
1943	61	121	1,139
1944	29	159	1,269
1945	29	177	1,417
1946	56	287	1,648
1947	75	263	1,836
1948	96	238	1,978
1949	103	189	2,064
1950	93	222	2,193
1951	114	228	2,307
1952	104	221	2,424

Losses by Death

It is with regret that the Council records the loss by death during the year ended April 30th, 1953, of the undermentioned Fellows:

	Date of Election
Barker, Rennie	1951
c Clark, Sir William H., G.C.M.G., K.C.S.I.	1901
Evans, I. L.	1925
Feavearyear, Sir A. E., K.B.E., C.B., D.Sc.	1938
*p**Godfrey, E. H.	1901
*Hemming, A. G., F.I.A.	1889
Hole-Baker, Edwin	1949
Maudling, R. G., F.I.A.	1927
Reynolds, R. C.	1927
*Taylor, T. C., J.P.	1888
Thomas, P. Scofield	1905
Watson, Sir John Forbes, K.C.M.G., M.A., LL.B.	1926
*cp**Webb, A. D., C.B.E.	1908
*p**Wilson, G. B.	1916

* Life Fellow. *p* Contributed to *Proceedings*.
c Served on Council.

Sir William Clark served the Society as Honorary Secretary from 1909–11 and was a member of Council during the same period. This was at the very time that, after varied experience in the Board of Trade and at the Exchequer, he was undertaking new and exacting work as Member for Commerce and Industry in the Executive Council for the Viceroy of India. His long and distinguished career in the public service included, at home, the development of the commercial intelligence department of the Board of Trade into the Department of Overseas Trade and the establishment of the British Industries Fair as a national institution; and overseas the successive holding of the posts of High Commissioner for Canada and of High Commissioner for Basutoland, the Bechuanaland Protectorate and Swaziland. As late as 1946, and when in retirement, he undertook official work again, touring the overseas posts under the control of the Dominions Office.

Mr. Ifor Evans, Principal of the University College of Wales and Vice-Chancellor of the University of Wales, who died at the comparatively early age of 55, was elected in 1925. His primary interests lay in economics and in economic history rather than in statistics. Academic brilliance was allied in him with a marked gift for organization, and both extensions of college buildings and increased facilities for agricultural research work were set in progress by him.

Sir Albert Feavearyear, who was elected to the Society in 1938, was a distinguished civil servant, economist and economic historian. He entered the Civil Service in the Paymaster General's Office, and subsequently served on the Empire Marketing Board, in the Exchequer and Audit Department, and in the Board of Trade. In 1939 he was appointed Assistant Director in the Food (Defence Plans) Department and from 1948 until his death was Deputy Secretary in the Ministry of Food.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Mr. E. H. Godfrey was a Fellow of long standing, his election dating from 1901. He worked mainly in the field of agricultural statistics. Appointed in 1907 as Editor of the Census and Statistics Office, Ottawa, his investigations were chiefly concerned with Canadian developments and his three contributions to the *Journal* dealt with agricultural subjects in particular application to Canada. In 1920 he was a joint Canadian delegate to the British Empire Statistical Conference.

Mr. T. C. Taylor was unique among Fellows in his great age (102) and the length of his Fellowship (64 years). The Society's greetings on his 100th birthday had been conveyed to him in 1950. He was widely known for his advocacy of the principle of profit-sharing, which he had successfully introduced into his wool-manufacturing business some sixty years ago.

Sir John Forbes Watson, who had been a Fellow since 1926, was a prominent figure in industry, a director of the British Employers' Confederation from 1921 and a member of many industrial and economic committees and conferences.

Mr. A. D. Webb became a Fellow in 1908. He served on the Council for fourteen years between 1921 and 1941 and two communications from him were published in the *Journal* in 1909 and 1913. Entering the Civil Service as a boy-copyist at the age of 14, he was, at the time of his retirement in 1944, an Assistant Secretary and Head of the Intelligence Division of Customs and Excise with special duties in the preparation of the Budget. Though his interest in statistics was mainly in comparability and exactitude of definition, he had a considerable knowledge of the mathematical technique and was the earliest student of the London School of Economics to obtain a First Class degree with Statistics as special subject.

Mr. G. B. Wilson, who died at the age of 88, was another of the Society's oldest Fellows, having been elected in 1916. An authority on the statistics of temperance, a cause to which he devoted his life, he was awarded the Howard Medal of the Society in 1911, being the last Fellow to receive this distinction.

Vice-Presidents

For the Session 1952/53 the President appointed as Vice-Presidents of the Society Professor G. A. Barnard, Mr. E. C. Fieller, Mr. Philip Lyle and Mr. L. H. C. Tippett.

Meetings of the Society

The Ordinary General Meetings of the Society during the Session have continued to be held in the lecture theatre of the London School of Hygiene and Tropical Medicine. The Council again wishes to acknowledge its gratitude to the Board of Management and to the Dean of the School for granting these facilities.

The papers read during the Session have been as follows:

1952	
November 19th	FISHER, Sir RONALD, F.R.S. Presidential Address: The Expansion of Statistics.
December 17th	KENDALL, Professor M. G. The Analysis of Economic Time Series—Part 1: Prices.
1953	
January 28th	DEANE, Miss P. Regional Variations in United Kingdom Incomes from Employment, 1948.
February 25th	PEAKER, G. F. A Sampling Design used by the Ministry of Education.
March 25th	RIX, Miss M. S. Construction of an Index Number of Gilt-Edged Values.
April 22nd	TIPPETT, L. H. C., and VINCENT, P. D. Statistical Investigations of Labour Productivity in Cotton Spinning.
May 27th	MOSER, C. A., and STUART, A. An Experimental Study of Quota Sampling.

The attendances have been well maintained but have shown a much wider range than in past sessions, with a maximum of 251 and a minimum of 49.

The Manchester Conference

A Joint Conference of the Royal Statistical Society and the Manchester Statistical Society was held at Ashburne Hall, Manchester, from September 19th to 21st, 1952. About 100 people were in residence for the duration of the Conference and nearly 150 attended the meetings. The Conference was opened by Dr. F. C. Toy, C.B.E., President of the Manchester Statistical Society.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The following papers were read:—

A. *Economic Statistics*

Regional Economic Statistics, with Special Reference to the North-West Region.—K. S. LOMAX.
The Use of the Electronic Computer in Business and Economic Statistics—B. B. SWANN.
The Development of the Cotton Industry and Trade—R. ROBSON.
A Survey of Electricity Consumers—G. R. REAH and T. R. SMITH.
The Consumer as Forecaster—HENRY DURANT.

B. *Industrial Statistics and Methodology*

A Regression Study in Steelmaking—D. R. G. DAVIES.
Rational Sampling in Industry—G. H. JOWETT.
The Meaning and Practical Importance of Stochastic Processes—M. S. BARTLETT.
Non-Normality and Tests on Variance—G. E. P. BOX.
Experiments for Comparing Variability in Chemical Analysis—D. H. WARD.

A and B. Investigations into Productivity in Cotton Spinning, by L. H. C. TIPPETT and P. D. VINCENT.

A visit was arranged to the British Cotton Industry Research Association, during which the joint paper was given. On the Monday after the Conference visits were arranged to Ashton Brothers & Co. Ltd., Ferranti Ltd., and the Computing Machine Laboratory at the University of Manchester. The Council joins the Council of the Manchester Statistical Society in extending its thanks to the directors of these establishments who made the visits possible, and in particular to Dr. Toy who, as the Director of the British Cotton Industry Research Association, was responsible for making the arrangements at the Shirley Institute.

The organisation of the Conference was in the hands of a committee consisting of Mr. L. H. C. Tippett, Professor M. S. Bartlett, Professor E. Devons, Mr. T. J. Lunt and Mr. A. C. Wild.

The Research Section

Professor M. S. Bartlett has served for a second year as Chairman of the Research Section, and Dr. P. Armitage was elected Honorary Secretary. The other members of the Section's Committee have been: Mr. G. E. P. Box, Mr. J. Durbin, Mr. J. M. Hammersley, Mr. M. J. R. Healy, Mr. D. V. Lindley, Mr. D. Newman, Mr. R. L. Plackett, Dr. K. D. Tocher, with Mr. E. C. Fieller and Professor M. G. Kendall nominated by the Council, and Dr. J. O. Irwin an *ex-officio* member as Editor of Series B of the *Journal*.

At the fourth meeting of the Session a paper was read by Professor Harold Hotelling of the University of North Carolina. It was a great pleasure to the Research Section to welcome so distinguished a visitor.

The papers read during the Session have been as follows:

1952		
October 29th	ANSCOMBE, F. J.	Sequential Estimation.
1953		
January 21st	LINDLEY, D. V.	Statistical Inference.
March 18th	SMITH, C. A. B.	The Measurement of Linkage in Human Genetics.
May 13th	HOTELLING, H.	New Light on the Correlation Coefficient and its Transforms.

The Industrial Applications Section

The Section Committee which co-ordinates the functions of the separately organized Local Groups and links them with the Society has consisted of: Mr. D. J. Desmond, Mr. Philip Lyle, Mr. G. H. Jowett, Mr. E. D. van Rest, Mr. A. W. Swan (appointed by the Council); Miss Joan Keen, Mr. N. J. Squirrell, and Mr. P. J. Stanley (nominated by the 1951–52 Section Committee); together with the Chairman and Secretary of each of the Local Groups.

The Section Committee elected as officers: Chairman, Mr. N. J. Squirrell; Vice-Chairman, Mr. E. D. van Rest; and Honorary Secretary, Mr. P. J. Stanley.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The officers of the Local Groups were:

Group	*Chairman*	*Honorary Secretary*
Birmingham and District	Mr. M. Milbourn	Mr. C. H. Leigh-Dugmore
Glasgow	Mr. W. A. Bennett	Mr. A. Kirk
Leicester	Mr. K. Boyd	Mr. A. Bramley
London	Mr. G. W. Sears	Mr. M. Whyte
Merseyside	Mr. A. Howarth	Mr. R. L. Plackett
North-Eastern	Mr. D. Gold	Mr. H. Arnell
Sheffield	Mr. G. F. Komlosy	Mrs. J. Stewart
South Wales	Dr. T. V. Starkey	Mr. E. Lloyd

The Section Committee met twice during the Session and the business at these meetings included:

(*a*) A review of the policy regarding the formation of new Local Groups, since the first year's operation at provisional status was giving rise to anomalies and difficulties with procedure. In future, a Group may be formed immediately after the demonstration to the Section Committee of adequate support at an inaugural meeting.

(*b*) A review of the Section's Regulations and Standing Orders.

(*c*) Arrangements for the preparation of two papers, namely, "Statistics and Standardization" and "Education and Training for Statistics in Industry" for presentation at the Conference of the International Statistical Institute at Rome in the autumn of 1953.

(*d*) Arrangements for a Conference to be organized by the Section Committee, to take place in September, 1953.

On December 31st, 1952, the roll of members was as follows (1951 figures are given in brackets):

Local Group	*Fellows*	*Non-Fellows*	*Total*	*Average Attendance 1952–53*
Birmingham	33 (33)	28 (36)	61 (69)	33
Glasgow	5 (—)	49 (—)	54 (—)	60
Leicester	13 (—)	32 (—)	45 (—)	28
London	105 (280)	74 (90)	179 (370)	56
Merseyside	12 (—)	63 (—)	75 (—)	27
North-Eastern	15 (14)	13 (15)	28 (29)	20
Sheffield	21 (25)	47 (50)	68 (75)	15
South Wales	26 (11)	7 (12)	33 (23)	30
	230 (363)	313 (203)	543 (566)	

During the year the London Group membership list was reviewed and all Fellow members asked to confirm their active interest. The drop in membership of the Group is due to the elimination of those Fellows who held nominal membership in order to receive notices of meetings and to the affiliation of a number of members in the provinces to the new Groups at Glasgow, Leicester and Merseyside.

The accounts of the Section and its Local Groups for the calendar year 1952 (excluding expenditure incurred by the Society in relation to the work of the Section) are summarized below:

Expenditure	£	*s.*	*d.*	£	*s.*	*d.*
Birmingham	21	3	10			
London	17	8	11			
North-Eastern	8	4	4			
Sheffield	18	14	10			
South Wales	19	17	1			
Section Secretary	55	8	4			
				140	17	4
Carried forward to 1953				33	14	3
				£174	11	7

Income	£	*s.*	*d.*
Brought forward from 1951	33	11	7
Grants from Council	141	0	0
	£174	11	7

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

In November, 1952, the Merseyside, Leicester and Glasgow Local Groups were recognized formally by the Section. The Council welcomes the increase in interest in various parts of the country which this expansion demonstrates.

Fifty-three meetings have been held by Local Groups: 7 each in Birmingham, Liverpool, London, Newcastle-on-Tyne and Sheffield; 6 in Leicester; 5 in Glasgow; 2 each in Cardiff, Newport and Swansea; 1 in Wolverhampton.

The subjects dealt with at the meetings were:

Birmingham and District Group

1952	
September 24th	Designed Experiments and their Relationship with Statistical Quality Control—M. Milbourn.
October 29th	Statistical Quality Control in a Laboratory—B. J. A. Martin.
November 26th	Analysis and Cost of Labour Turnover—J. Murdoch.
1953	
January 7th	Everyday Uses of Probability—M. J. Moroney.
January 28th	Sources of Variation in a Transformer Sheet Mill—A. D. Grace.
February 25th	Elimination of Trends—O. L. Davies.
March 25th	Ranking Methods—M. G. Kendall.
April 29th	Statistical Quality Control and the Analysis of Variance—V. E. Gough.

Glasgow Group

1952	
October 15th	Control Chart Techniques as an Aid to Supervisory and Executive Staff—B. P. Dudding.
November 19th	Quality Control Applications—W. A. Bennett.
1953	
January 20th	Statistics in the Explosive Industry (A Symposium).
February 12th	Statistical Methods in the Hosiery Industry—A. Glaskin.
March 4th	Probability and Statistics—Barnet Woolf.

Leicester Group

1952	
October 9th	Applications of Analyses of Variance to Industrial Problems—A. Hardy and A. Bramley.
November 13th	Patrol Inspection—M. J. Moroney.
December 4th	Statistical Methods in the Hosiery Industry—A. Glaskin.
1953	
January 29th	Short Cut Analysis of Variance Based on Range—H. O. Hartley.
February 26th	The Use of Statistics in Consumer Research—P. Harper.
March 12th	Snap Observation Methods Used in a Factory—K. Boyd.

London Group

1952	
October 3rd	The Design and Analysis of 2^n Factorial Experiments with Fractional Replication—G. W. Sears.
November 7th	A Discussion of Hand-Operated Punched Card Systems—Joan Keen and L. T. Wilkins.
December 5th	The Statistical Approach to Congestion Problems in Industry—J. Murdoch.
1953	
February 6th	Selling Statistics to Industry—M. J. Moroney.
March 6th	Certain New Sequential Procedures—S. Rushton.
April 10th	A Statistical Department in the Gas Industry—J. Reece.
May 1st	The Utility and Futility of Statistics Illustrated by Paper-making Research—A. F. Tout.

Merseyside Group

1952	
October 16th	The Scope of Industrial Statistics—W. J. Jennett.
November 18th	Transformations Used in Statistical Analysis—R. L. Plackett.
December 16th	Tolerances—G. A. Barnard.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

1953
January 22nd — Statistics in Glass Manufacture—J. P. L. Truesdale.
February 24th — A Study of Variation in Concrete Strength—B. E. Roberts.
March 24th — The Control of Quality in the U.S.A.—E. D. van Rest.
April 21st — The Evaluation of Detergent Performance in Domestic Dish-Washing—C. Pugh.

North-Eastern Group

1952
October 15th — Quality Control in the U.S.A.—E. D. van Rest.
November 19th — Accident Records—H. Campbell.
December 17th — Economic Statistics—E. D. McCallum.

1953
January 21st — The Adequacy of Underground Communication Systems—B. H. P. Rivett.
February 18th — Statistical Control as an Aid to Management in Industry—A. W. Swan.
March 18th — Self Protection in Purchasing: Practical Sampling Schemes—W. J. Ross.
April 15th — Some Statistics of Interviewing—N. J. Squirrell.

Sheffield Group

1952
September 24th — Graphs and Correlation—D. G. Beech.
October 30th — Statistically Based Production Control of Heterogeneous Output—S. Beer.
November 27th — Some Problems of the Sampling of Airborne Dust in Coal Mines—B. A. Maguire.

1953
January 29th — The Correlation of Time Series, with Special Reference to Routine Works Data—G. H. Jowett.
February 26th — Some Statistical Problems in a Card Game of Patience—S. Peiser.
March 26th — The Choice between Alternative Statistical Tests—E. S. Pearson.
April 30th — Some Experiments Involving Subjective Judgment—W. N. Jessop.

South Wales Group

1952
October 2nd — Statistics in Research—A. W. Swan.
November 6th — Statistical Techniques to Determine Optimum Conditions—G. E. P. Box.
December 11th — British Earnings 1938–50—E. J. Cleary.

1953
January 29th — Quality Control into Operational Research—A. W. Swan.
February 26th — Queues, and some Inference Problems in Industry—W. D. Ewan.
March 19th — Some Administrative Problems of a Statistics Department—R. F. George.
April 23rd — Application of Statistical Methods to Problems of Mining—B. H. P. Rivett.

Thanks are due to the Goodyear Tyre and Rubber Co. Ltd. for hospitality at Wolverhampton and to the Electric Lamp Manufacturers' Association for providing accommodation for meetings in London.

The Study Section

The members of the Section Committee during the past Session have been: Mr. L. T. Wilkins (Chairman), Miss S. V. Cunliffe (Honorary Secretary), Mr. K. F. Glover, Dr. H. O. Hartley, Mr. J. I. Mason, Dr. C. Nuttall, Mr. G. P. Salter and Mr. M. Rudd. Dr. Hartley and Mr. Wilkins were the Council's representatives. In addition, a member of the Bristol Group is entitled to attend meetings of the Section Committee, and a representative of the Study Circle on Medical Statistics has usually been present. Four Committee meetings have been held.

In London the following meetings, all of which have been held at the E.L.M.A. Lighting Service Bureau, were arranged.

1952
October 8th — The Accountant and Statistician in Business—F. Sewell Bray and C. Nuttall.
November 12th — The 1951 Census: 1 per cent. Sample—E. Grebenik and J. I. Mason.
December 10th — The Compilation of Statistics about the Post Office—S. Wood.

1953
January 14th — The Design of Schedules—D. L. Lamberth.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

February 11th	Money Making and Money Saving by Statistical Methods—G. A. Bennet, W. R. Buckland, T. Cauter and J. Murdoch.
March 10th	Possibilities and Limitations of Electronic Computors in Statistical Problems—J. A. C. Brown.
April 8th	A Survey of Economists' Forecasts for 1953—E. Shankleman.
May 19th	Annual General Meeting followed by a Paper on Sample Surveys and their Use for Administrative Purposes—L. Moss.

Attendances have varied from 13 to 110 with an average of 63. In addition to the monthly meetings, on April 16th 55 members of the Section accepted an invitation of the British Tabulating Machine Company to tea followed by a demonstration of machine methods. The Section is very grateful to the British Tabulating Machine Company for their hospitality.

During the current session, the local committee of the Bristol Group has consisted of Dr. G. Herdan (Chairman), Mr. H. C. Mackenzie (Honorary Secretary), Mr. D. A. Clark and Mr. W. R. Foster. Six meetings were held, at which the following subjects were discussed:

1952	
October 21st	Discussion on the Census of Distribution—D. A. Clark.
November 18th	Statistical Problems in Meteorology—N. Goldie and R. W. Gloyne.
December 12th	An Attempt at a Quantitative Analysis of Children's Behaviour—D. H. Stott.
1953	
January 20th	The Limitations of Cost-of-Living Index Numbers—H. C. Mackenzie.
February 17th	A Comparison of the Findings of Quota Samples and Random Samples—M. Abrams.
March 17th	The Change of Statistical Method with Branch of Knowledge. A Symposium—A. F. Devonshire, F. H. George, G. Herdan, H. C. Mackenzie.

Attendances, ranging in number from 15 to 30, were slightly less than in previous years.

The Study Circle on Medical Statistics has now completed its first full year and is obviously fulfilling a real need in providing those interested in medical statistics with an opportunity to meet and discuss their problems. By kind permission of the Dean, the following meetings have been held in the Westminster Hospital Medical School.

1952	
September 30th	The Validity of Medical Records—Marion H. Russell.
October 28th	The Spread of Influenza within Households—Ian Sutherland.
November 25th	Medical Records in a General Practice—A. Garvie.
1953	
January 27th	Sickness Absence Statistics—F. J. Lloyd, K. Murden.
February 24th	The Nature and Sources of Medical Statistics—B. Benjamin.
March 31st	Regional Hospital Statistics—J. H. Austin.
April 28th	Having a First Baby—Angus M. Thomson.
May 26th	Some Aspects of Mortality in Scotland—Lilli Stein.

Attendances at these meetings have been good, varying between 20 and 30 and the discussions that have followed the papers have been stimulating. The meetings of the Study Circle will in future be advertised on the monthly card sent to Fellows. Membership is not restricted to people living in London; the Circle already includes statisticians from Edinburgh, Manchester and Oxford amongst those regularly attending its meetings. Small groups are studying various subjects in detail.

The Council is again indebted to those who have so kindly provided the Study Section with accommodation for their meetings and would like to take this opportunity of thanking the Electric Lamp Manufacturers' Association, the University of Bristol and the Westminster Hospital Medical School.

Award of the Guy Medal in Gold and in Silver

It is in the Council's power to make an award of the Guy Medal in Gold every five years (beginning 1935) unless by special resolution it directs an award at an intermediate date. The last occasion such an award was made was in 1946 and recommendations were accordingly invited again during the past Session. As a result, it gave the Council considerable pleasure to award this supreme distinction to Professor A. Bradford Hill, C.B.E., D.Sc. For many years he has occupied a pre-eminent position in the field of medical statistics, in which he commands the highest

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

regard not only in this country but also overseas. It was a tribute to his international reputation that he was recently elected an Honorary Fellow of the American Public Health Association "in recognition of his outstanding services in the field of public health".

The Council was most pleased to accept unanimously the advice of its Executive Committee to award the Guy Medal in Silver to Dr. J. O. Irwin in recognition of his contributions to statistical methodology, particularly in the field of bio-assay. Dr. Irwin has of course been closely identified with the Society's interests for many years and has materially contributed to advances in methodology not only by his personal publications but also in his capacity, since 1948, as Editor in Chief of Series B of the *Journal*.

The Frances Wood Memorial Prize

The Council greatly regrets that no essays were received for the Frances Wood Memorial Prize competition in 1952. Much thought has been given to this lack of response and the possible reasons for it. The need to encourage the younger investigator is no less strong now than in former years and the Council has therefore decided to increase the value of the Prize to be offered in 1954.

The Society's Examinations

Twenty-five candidates for all or part of the Society's Certificate and one for its Diploma presented themselves for the examinations held on March 25th, 26th and 27th, 1953. Certificates have been awarded to the following Fellows :

Clinch, Charles Ernest Everard.
Cork, George.
Davies, Glyn James.
Gloyne, Ronald Westlake.
Hansman, Denis Alfred.
Heslop, Ian Gordon.
Kesteven, William Leofric.
Lynch, Peter Donald.
Miles, Gerald.
Rich, Harold Stanley.
Sampson, William John.
Waterman, Shiela Patricia Margaret Isabella.
Watkins, Henry Richard William.
West, John Harold.
Whiteside, George Denby.
Wilson, Andrew Lawrence.

Provision was made again this year for the Certificate examination to be held overseas, and the Council is grateful to Mr. J. R. H. Shaul (Salisbury, Southern Rhodesia) and Mr. L. C. Wilcher (Principal, University College of Khartoum), who accepted responsibility for arranging the examinations in these centres.

The Council has again to acknowledge its indebtedness to the London School of Hygiene and Tropical Medicine for granting the necessary facilities for holding the examinations in its Department of Medical Statistics and Epidemiology. It also extends its thanks to those Fellows of the Society who acted as invigilators and to the Examinations Committee and others who have helped the Committee in its work. The membership of the Committee has been: Mr. E. C. Fieller (Chairman), Professor R. G. D. Allen, Professor G. A. Barnard, Mr. B. Benjamin, Mr. W. J. Corlett, Mr. J. Durbin, Dr. H. O. Hartley, Mr. F. A. A. Menzler, Mr. D. Newman and Professor E. S. Pearson.

The Journals

In 1952, for the first time since before the war, all four parts of the volume of Series A were published within the calendar year, thus realizing an ambition which the Editors have cherished for many years. During 1952 there were issued five parts of Series A—the fourth part of the volume for 1951 and the four parts of that for 1952. Part I of the 1953 volume, published early in May, appeared some six weeks earlier than the corresponding part in 1952.

Two parts of the Journal, Series B, were again published in 1952. The Council is indebted to the Editorial Panel responsible for this Series which has consisted of: Dr. J. O. Irwin (Chief Editor), Mr. F. J. Anscombe, Professor G. A. Barnard, Professor M. S. Bartlett, Dr. H. E. Daniels, Dr. O. L. Davies, Mr. E. C. Fieller, Dr. H. O. Hartley, Mr. D. G. Kendall, Professor M. G. Kendall, Dr. C. A. B. Smith, Mr. J. R. N. Stone, Dr. F. Yates.

Under the continued guidance of Professor Kendall, articles on the sources and nature of the statistics of the United Kingdom have appeared in the Journal and additional contributions to this series are in preparation. Up to the end of 1952 25 papers in this series had been published

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

and a further five are in the press. The Council is glad to express its appreciation of the time and interest devoted to this work by Professor Kendall. The first set of 20 papers was published for the Society at the beginning of May 1952 by Messrs. Oliver and Boyd, who report steady sales with an encouraging demand from overseas.

It was stated in the last Annual Report of the Council that the size of the Journal was causing much concern. At a cost of over £4,000 for Series A, there was clearly placed on the Editors a responsibility to resist the tendency for the Journal to increase in size. Readers of papers, contributors of articles and reviewers were therefore asked to exercise the virtue of brevity. During 1952 however the result was disappointing and last year's volume ran to just over 600 pages, as in the two previous years. It has therefore become imperative to impose a strict limitation on the length of papers, other contributions and reviews for the 1953 volume, and Fellows will already have noticed that the papers read during the current session have been more concise than was formerly the case. It is hoped that this policy will achieve a substantial reduction in the printer's account without any sacrifice of quality or clarity in the contents of the Journal.

Before the issue of the first number, *Applied Statistics* was well publicized by means of advertisements in the *Journals* of the Society and by the wide circulation of a prospectus at home and overseas. Review copies were also sent to appropriate journals in many countries. In the result there were 1,496 subscribers to the first number, of whom about one-half were from overseas. It is disappointing that the total includes only 545 Fellows. The Council would be glad to see a substantial increase in the number of subscribers during the next year or two.

There is every sign that the Council was justified in establishing *Applied Statistics*. There is clearly a public for the Journal and this reviews have been favourable. Articles have been submitted in sufficient numbers and variety to permit of some selection, so that the Journal has not only developed a distinctive character but has also provided a medium for the publication of articles that otherwise would not see the light of day. Contributions are always welcome, especially short elementary articles describing statistics in action in industry, and prospective authors may take encouragement from the fact that so far it has been possible to print all suitable articles submitted without undue delay.

The *Applied Statistics* Committee has been as follows: Mr. L. H. C. Tippett (Editor), Mr. R. F. Fowler, Dr. J. O. Irwin, and Mr. Philip Lyle (representing the Council); Dr. O. L. Davies, Mr. G. H. Jowett, and Mr. E. D. van Rest (nominated by the Industrial Applications Section); Mr. C. A. Moser, Mr. E. Shankleman, and Mr. L. T. Wilkins (nominated by the Study Section). The nominees of the two Sections and the Editor act as a panel of referees for articles, and the Council thanks them for their labours.

The Library

The Library Committee of the Council report that the services given to Fellows and others authorized from time to time to use the Library during 1952 can be summarized statistically as follows:

	1950	1951	1952
Number of Fellows who borrowed books	370	347	391
Number of effective applications for books	1,371	1,180	1,297
Number of volumes borrowed by Fellows	2,580	2,112	2,419
Number of signatures of Fellows and visitors using the Reading Room	597	556	739
Non-serial works added to the Library	492	529	594

In 1952, as in 1951, about 400 weekly, monthly and quarterly periodicals were received.

The Committee has continued its scrutiny of all requests made for books which could not be met from the Library's resources. The number of applications made for works or titles not in the Library was 241 as against 190 in 1951 and 281 in 1950.

The work of strengthening and improving the services provided by the Library, made possible by the grant of the Rockefeller Foundation, has progressed. The Assistant Librarian has continued with the improvement of indexing and cataloguing and the task of producing an accurate record of the Library's substantial holdings of periodicals is nearing completion.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Committee has had under consideration a number of problems connected with moving the Library to the new premises in Bentinck Street. The shelving will be entirely new and it is hoped by rearrangement to produce a select and separately catalogued section of the Library comprising the most frequently needed books.

As in former years the Society has received a number of donations from Fellows and others. It has in particular benefited by a bequest of books from the library of the late Mr. A. D. Webb.

Housing

At the time of the last Report the purchase of the lease of the new premises at 21, Bentinck Street, W.1, was not completed. Shortly afterwards the Society came into legal possession, but much remained to be done before the house could be occupied. Once the architects had prepared plans of the structural alterations necessary, first, to support the great weight of books and, secondly, to meet the requirements of the local authorities and the landlords, building permits had to be obtained and tenders from contractors received. At last, on April 8th, 1953, workmen began the alterations and it is now hoped that removal will be possible before the end of the year.

To deal with all problems connected with the alterations to the premises and with the removal, the Council in November, 1952, appointed a House Committee as follows: Mr. Philip Lyle (Chairman), the President, Miss Douglas, Professor A. Bradford Hill, Dr. J. O. Irwin, Miss Croker. In order to ensure the proper scrutiny of estimates and the supervision of expenditure, Mr. Fowler, the Honorary Treasurer, was immediately co-opted. It will be noticed that the interests of the Library are safeguarded by the inclusion of the Chairman of the Library Committee, while the appointment of Miss Croker ensures that office and staff considerations are given due thought. Technical advice has been sought as necessary from other members of Council and Fellows.

It is too soon yet to give details of the lay-out of the new premises. It may be of interest to report, however, that the Library will occupy the ground and first floors, with storage below, and that the Council Chamber on the second floor will not have to accommodate the office staff as is unfortunately necessary at Portugal Street. There will also be space for readers and for committee meetings.

Finance

Abstracts of the Honorary Treasurer's Accounts, viz., the Statement of Income and Expenditure for the year 1952 and the Balance Sheet as at December 31st, 1952, together with the Auditor's Report thereon, are contained in Appendices B, C and D.

Income, excluding Life Composition Fees received during the year, rose from £11,596 in 1951 to £13,505 in 1952. The increase in the number of Fellows was reflected in a rise of Fellowship subscriptions from £5,603 to £5,886. There was a substantial increase in receipts from sales of the Society's two Journals. Sales of 5 issues of Journal A realized £3,367 compared with £2,389 for 4 issues published in 1951. Sales from Journal B rose by £463. Expenditure chargeable to the Rockefeller Foundation Grant amounted to £866 and this amount has been taken to Income for the year. The balance at December 31st, 1952, remaining from the first instalment (£1,735) of the grant, is shown in the Balance Sheet. Following the grants of £400 in 1950 and £350 in 1951, the Royal Society made a further grant in 1952 of £400, bringing the total aid from this source to £1,150. The Council records its deep appreciation of this generous help.

Expenditure rose from £11,673 in 1951 to £13,835 in 1952. This increase is very largely accounted for by the higher publication and distribution expenses of the two Journals, which rose from £5,928 to £7,902. This was the result partly of the fact that 5 issues of Journal A were published in 1952 compared with 4 in 1951, and partly of the greater number of pages included in each issue of both journals. Expenditure on publication and distribution of Journal A exceeded receipts from sales by £2,094 in 1952 (5 issues) compared with £1,749 in 1951 (4 issues) and £1,306 in 1950 (5 issues). For Journal B the excess of expenditure rose from £579 to £767. There were increases of £342 in salaries and wages, £85 on the Library, £74 on General Meetings and £46 in examination expenses; but decreases of £94 on Office and Library Equipment, £83 on Stationery and miscellaneous printing and £83 on expenses of the Sections.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The Financial Accounts have been signed by the Auditor with a note that no provision has been made for a possible liability that may have been incurred on the publication of *Applied Statistics*. Separate accounts are kept by the publishers, Messrs. Oliver and Boyd, and by the terms of the agreement any deficit at the end of each year is to be made good by the Society, any credit balance being paid to the Society. Unfortunately the preparation of this special account has been delayed and it has therefore not been possible to incorporate the results in the Society's Accounts for 1952. The Council understands, however, that *Applied Statistics* has more or less paid its way during 1952 and that any deficit, if there is one, will be quite small.

As a result of the year's operations there was a deficit of £330 in 1952 compared with a deficit of £77 in 1951.

Composition Fees received during the year rose from £241 in 1951 to £555 in 1952. After allowing for the fees of compounders who died during the year or were presumed to have died in previous years, the Composition Fee Fund, maintained at the total of composition fees received from Fellows still living, amounted to £7,457 at the end of the year.

The cost of acquiring the lease of 21, Bentinck Street in July, 1952, was met by realizing part of the 2½ per cent. Funding Loan 1956/61 held in the Benefaction Fund and the balance was subsequently re-invested in 3½ per cent. British Electricity Stock 1976/79. Since the property is leasehold, provision has been made for amortizing the capital cost already incurred and the further capital expenditure on certain essential alterations to the premises. A first instalment of £212, covering the 6 months from July to December, 1952, has accordingly been charged to Expenditure and invested in 3½ per cent. British Electricity Stock 1976/79. The Council decided that the income earned on the remainder of the Benefaction Fund should, as from July, 1952, be taken to Income each year to meet the Sinking Fund charges, ground rent, and other expenses associated with the new premises. Appendix B therefore includes a new item of £202 on the Income Side and £296, representing the Sinking Fund payment, ground rent and insurance, on the Expenditure Side. After allowing for a loss on realization of investments the Benefaction Fund stands at £30,971.

A detailed schedule of the Society's investments is given in Appendix D.

The Council and Officers

Sir Ronald Fisher, F.R.S., has consented to serve as President for the forthcoming session and in recording its pleasure on this account, the Council extends to him its felicitations on the honour of knighthood conferred on him in June last year.

The retiring members from the Council of last Session are Mr. J. R. N. Stone, Mr. L. H. C. Tippett, Dr. H. O. Hartley, Professor E. Devons, Professor M. S. Bartlett and Professor J. H. Richardson and the thanks of the Council are due to them for the services they have rendered. After compliance with the Bye-laws and due consideration by the Council of the suggestions received, Mr. H. Campion, Miss S. V. Cunliffe, Dr. D. J. Finney, Miss J. E. Keen, Mr. C. A. Moser and Dr. F. Yates were recommended to fill the six vacancies for ordinary members of the Council. No alternative proposals were received and the Fellows named below will be announced

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

at the Annual General Meeting on June 24th, 1953, as having been elected President, other officers, and other members of Council for the Session 1953–54.

President

Sir Ronald Fisher, F.R.S.

Council

R. G. D. Allen.
F. J. Anscombe.
G. A. Barnard.
W. R. Buckland.
*H. Campion.
G. D. Champernowne.
†Stella V. Cunliffe.
E. C. Fieller.
*D. J. Finney.
R. Glenday.
J. O. Irwin.
†Joan E. Keen.
M. G. Kendall.
G. H. Jowett.
W. P. D. Logan.
Sir George Maddex.
F. A. A. Menzler.
†C. A. Moser.
D. Newman.
E. D. van Rest.
J. Ryan.
L. G. K. Starke.
A. W. Swan.
L. T. Wilkins.
J. Wishart.
*F. Yates.

Honorary Treasurer

R. F. Fowler.

Honorary Secretaries

R. F. George. Philip Lyle. Iris Douglas.

On behalf of the Council,
R. A. Fisher,
President.

R. F. George
Philip Lyle
Iris Douglas
} *Honorary Secretaries.*

June 1st, 1953.

Those marked * were not Members of Council during the preceding session; those marked † have never served on the Council.

APPENDIX A

From June, 1952 to May, 1953, inclusive, the candidates named below were elected Fellows of the Society:

Abdel-Aty, Soliman Hasan.
Alcock, Thomas Daniel.
Ali, Mir Maswood.
Arnold, Edward.
Arumugam, Lily Gnanaratnam.
Asante, Kwaku Baprui.

Barker, Hubert Oswald Earle.
Bauer, Peter Thomas.
Bennett, Gerald Malcolm.
Bennett, John Richard.
Berry, James
Billewicz, Wladyslaw Zbigniew.
Biswas, Parimal.
Bleazard, George Bernard.
Bliss, Chester Ittner.
Boreham, Arthur John.
Bowes, Stuart Ashley.
Breslauer, Cyril Samuel.
Brierley, Harry.
Broadbent, Simon Ralph.
Brook, Ronald Edgar.
Browell, Thomas Peter.
Browning, Peter Richard.

Carpenter, Robert Gordon.
Cartwright, Ann.
Chacko, K. Joseph.
Chaudhuri, Bimalesh Ray.
Clark, Alfred George.
Coblentz, Harry Stagg.
Colegrove, Elizabeth Anne Theresa.
Collinge, Robert Maurice.
Cooper, Donald Frederick.
Copeland, Alexander Cubie.

Daly, Charles.
Dani, Dattatraya Shripad.
Dantzig, D. van.
David, Stephen Trevor.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Denton, Arthur Denis.
Dillicar, Douglas Owen.
Dor, Leopold.
Draper, John.

Eldridge, James.
Elmasry, Farid Fahmy.
Elnaby, Mohamed Farid Desouky Hassab.
Enemuo, Jason Hanekwu Bieronwu.
Evinton, Charles Frederick.
Etienne, Joseph René.

Finch, Derek John.
Fox, Laurie Frederick.

Gill, Frederick Denis.
Gleeson, William Joseph.
Goatman, Geoffrey Mitchell.
Goldberg, Derek.
Goodman, Richard Hacklett.
Gorham, Lawrence John.
Goulding, Donald.
Gratwick, John.
Gronow, David Gwilym Colin.

Hainey, Eunice.
Hall, Richard Sutherland.
Harewood, Rupert Jackson.
Hayward, Henry.
Heslop, Ian Gordon.
Hewitt, Alfred Donald.
Hewitt, David.
Hill, Ian David.
Hill, Stanley.
Hodnett, George Edward.
Hooper, Peter Martin.
Hossain, Khondkar Manwar.
Howie, Alastair James.
Humphries, Denys William.
Huttly, Norman Alfred.

Jai, Bhanoo Shashikant.
Jenkins, Peter Thomas.
Jones, Albert Ernest.
Jones, Hugh John McNab.
Jones, William Wood.

Kellerer, Hans.
Kesavan, A. V.
Khandker, Mir Abu Hamed Rezaul Hoque.
Kibble, Walter Frederick.
Kreps, Michael Harold.

Lake, Leonard Edward.
Lambert, John Kenneth.
Langdale, George Richmond.
Lehman, Alcuin Williams.
Lemarié, Yves.
Lewis, Peter Owen.
Leyland, Norman Harrison.
Libby, Ernest Guy.
Lilley, George Gordon.
Lim, Kim Teck.
Liminton, Kenneth William Henry.
Loraine, Margaret Helen.
Loraine, Phyllis Katharine.
Lury, Dennis Albert.
Lyster, Michael St. George.

McAllister, Denis Walter.
McDonald, Ian.
McKenzie, Helen Macrae.
McTaggart, George.
Macer, Ronald.
Malek, Benjamin Seew.
Matheson, William Roderick.
Maurice, Rita Joy.
Mellor, George Eric.
Miles, Gerald.
Mossop, Isaac Alan.
Muller, Ervin George.
Mussett, Marjorie Violet.

Nesbit, John Rowan.
Newell, David John.
Nixon, William Lewis Benedict.
Noyce, Maurice Rowland.

Ogilvie, Geoffrey Caton.
Oglesby, Stanley.
Oliveira, José Tiago da Fonseca.
Ong, Soon Ann.

Palmer, Drayton Salisbury.
Perkins, Thomas Alan.
Peto, Stephen.
Piller, Gordon James.

Radford, Kenneth James.
Rao, K. S.
Rich, Cyril Douglas.
Rich, Harold Stanley.
Roy, Sunil Kumar.
Royle, Elsie.
Russell, Francis Thomas.

Salam, Abdus.
Salkind, Josephine.
Sanderson, Robert Brian.
Searle, Shayle Robert.
Shakespeare, William.
Sharma, Om Chandra.
Simpson, Marjorie.
Skinner, Robert, Sydney.
Slimak, Romuald.
Smith, Charles Stanley.
Smith, Hubert Alan.
Soper, Alan Kingston.
Spencer, Clifford.
Squire, John.
Stein, Lilli.
Stevens, Colin Frederick.
Stewart, William Richard.
Swan, David Macdonald.

Taylor, Alastair William Gibson.
Taylor, Gordon William.
Taylor, Robert John.
Thompson, Jean Helen.
Thomson, John Michael.
Tilston, John.
Timperley, Betty.
Tompkins, William Arthur.
Toon, Thayne.
Turnbull, Hugh Douglas.
Tye, Cho-Yook.

Ulmo, Jeanne.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Walters, Alan Arthur.
Watkins, Henry Richard William.
Watson, Geoffrey Stuart.
Webb, Norman Leonard.
Weiss, Samuel.
West, Arthur Leslie Alabaster.
Whitton, Howard James George.
Wilks, Samuel S.
Williams, Thomas Eifion Hopkins.
Willmott, Eric Basil.
Wilson, Kenneth.
Woolrich, Harry Frederick.
Wrigley, John.
Wright, Charles Frederic.
Wright, Valerie.

Yamauti., Ziro

Corporate Representatives

Ashton, Denis,	*representing*	British Timken Ltd.
Audley, George Bernard,	*representing*	Hulton Press Ltd.
Baker, Augustus Edward,	*representing*	Chambers' Encyclopaedia.
Brand, Cecil Howard,	*representing*	Vauxhall Motors Ltd.
Khan, Noor Mohammad,	*representing*	The State Bank of Pakistan.
Leedon, Desmond Francis Kiernan,	*representing*	Philips Electrical Ltd.
Menneer, Stephen Snow,	*representing*	The Ministry of National Insurance.
Wiggs, Peter Kenneth,	*representing*	The Morgan Crucible Co. (Mathematical Section).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPEN

STATEMENT OF INCOME AND EXPENDITURE

EXPENDITURE

1951 £	£		1952 £	£
	380	Rent		380
	375	House expenses		399
	2,296	Salaries and wages (including contribution to staff superannuation scheme)		2,638
	250	Pension		250
	23	Insurance		23
	171	Office and Library equipment		77
	168	Postage and telephone		135
	693	Stationery and miscellaneous printing		610
		Publication and distribution expenses:		
4,138		Journal, Series A (General) and reprints	5,461	
1,790		Journal, Series B (Methodological) and reprints	2,441	
	5,928			7,902
	393	*Publication of Sheffield Conference Papers*		—
		Library:		
176		Books	255	
176		Binding	182	
	352			437
	132	General Meetings—ordinary and annual		206
	41	Council and committee travelling expenses		24
		Expenses of sections:		
58		Research	37	
207		Industrial Applications	143	
27		Study	29	
	292			209
	7	Guy Medal		8
		Examination expenses:		
40		Printing, stationery, postage etc.	83	
57		Examiners' fees	60	
	97			143
	37	Auditor's fee (1951)		37
	38	Miscellaneous expenses		61
		Leasehold Premises:		
	—	Charge for amortisation of lease	212	
	—	Ground rent, insurance, etc.	84	
				296
	11,673			13,835
	241	Amount carried to Life Composition Fee Fund		555
	£11,914			£14,390

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

DIX B

FOR THE YEAR ENDED 31ST DECEMBER, 1952

INCOME

1951 £	£		1952 £	£
		Annual subscriptions:		
5,603		Fellowship	5,886	
2		Research Section	3	
80		Industrial Applications Section	78	
13		Study Section	15	
	5,698			5,982
	50	Contribution from Royal Economic Society		50
	621	Dividends and interest (gross)		639
		Sales of Journal:		
2,389		Journal, Series A (General) and reprints	3,367	
1,211		Journal, Series B (Methodological) and reprints	1,674	
	3,600			5,041
	3	Sales of other publications		45
		Examination receipts:		
136		Fees	123	
15		Sale of papers	17	
	151			140
	350	Grant from Royal Society		400
	666	Grant from Rockefeller Foundation—expenditure appropriated thereto		866
	—	Surplus from Manchester Conference		35
	457	Transfer from Life Composition Fee Fund, being fees of compounders known to have died during year and of those presumed to have died in previous years		105
	—	1950 Benefaction Fund—income from date of acquisition of Leasehold Premises		202
	11,596			13,505
	77	Deficit carried to Accumulated Fund		330
	11,673			13,835
	241	Life Composition Fees received during year		555
	£11,914			£14,390

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPEN

BALANCE SHEET AT

FUNDS AND LIABILITIES

1951 £	£		1952 £	£
		Accumulated Fund:		
7,212		Balance at 31st December, 1951	7,135	
77		*Less:* Balance per Statement of Income and Expenditure ...	330	
	7,135			6,805
		Life Composition Fee Fund:		
7,223		Balance at 31st December, 1951	7,007	
241		*Add:* Life Composition Fees received during year	555	
7,464			7,562	
457		*Less:* Transfer to Statement of Income and Expenditure of fees of compounders known to have died during year, and of those presumed to have died in previous years	105	
	7,007			7,457
		Building Fund (per contra):		
1,331		Balance at 31st December, 1951	1,380	
49		*Add:* Income for year	52	
	1,380			1,432
		1950 Benefaction Fund (per contra):		
30,484		Balance at 31st December, 1951	30,970	
693		*Add:* Income up to date of acquisition of Leasehold Premises ..	392	
31,177			31,362	
207		*Less:* Loss on realization of investment	391	
	30,970			30,971
		Liabilities and Income held in suspense:		
2,754		Sundry Creditors	2,767	
1,561		Amounts received in advance	1,404	
	4,315			4,171
1,735		*Grant from Rockefeller Foundation:*		
—		Balance as at 31st December, 1951	1,069	
666		*Less:* Expenditure during year appropriated thereto	866	
	1,069			203
	51,876			51,039
		Frances Wood Memorial Fund (per contra):		
523		Balance at 31st December, 1951	544	
21		*Add:* Income for year	22	
	544			566
	£52,420			£51,605

REPORT OF

I have obtained all the information and explanations which to the best of my knowledge and have been kept by the Society so far as appears from my examination of those books.

I have examined the above balance sheet and annexed statement of income and expenditure tion and according to the explanations given me the Balance Sheet gives a true and fair view of the gives a true and fair view of the income and expenditure for the year ended on that date.

5, London Wall Buildings, E.C.2;

15th May, 1953.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

DIX C

31ST DECEMBER, 1952

ASSETS

1951 £	£			1952 £	£
15,157		*Investments*, per schedule attached ... ... (Market Value, 31/12/51 £15,712, 31/12/52 £15,265)			15,157
		Building Fund:			
1,380		Investment, per schedule attached ... ... (Market Value, 31/12/51 £1,194, 31/12/52 £1,203)			1,432
		1950 Benefaction Fund:			
		Leasehold Premises:			
—		Cost of acquisition	15,174		
—		*Less* Amortisation to 31st December, 1952	212		
			14,962		
		Sinking Fund Investment, per schedule attached			
—		(Market Value, 31/12/52 £212)	212		
—				15,174	
—		Furniture at cost		225	
30,784		Investment, per schedule attached ... ... (Market Value, 31/12/51 £30,792, 31/12/52 £15,121)		15,249	
176		Interest accrued		76	
10		Cash at Bank		247	
—	30,970			—	30,971
		Current Assets:			
205		Debtors and amounts paid in advance		657	
100		Arrears of subscriptions recoverable (estimated)		100	
172		Interest accrued on investments (gross)		172	
3,892		Balances at banks and cash in hand		2,550	
—	4,369			—	3,479
	51,876				51,039
		Frances Wood Memorial Fund:			
300		Investment, per schedule attached ... ... (Market Value, 31/12/51 £397, 31/12/52 £395)		300	
244		Post Office Savings Bank Deposit		266	
—	544			—	566
	£52,420				£51,605

NOTES.—

(1) No value is placed in the Accounts on—
- (a) Journals and other publications in stock.
- (b) Books in library.
- (c) Pictures, furniture and equipment, other than furniture taken over with the Leasehold Premises, £225 (see above).

(2) No provision is made for a possible liability under a Publishing Agreement as the amount thereof, if any, has not yet been ascertained.

R. A. FISHER, *President.*
R. F. FOWLER, *Honorary Treasurer.*

THE AUDITOR

belief were necessary for the purposes of my audit. In my opinion proper books of account

which are in agreement with the books of account. In my opinion and to the best of my informa-
state of the Society's affairs as at 31st December, 1952, and the statement of income and expenditure

A. RAE SMITH, Auditor.
Chartered Accountant.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

APPENDIX D

SCHEDULE OF INVESTMENTS—31st DECEMBER, 1952

1951 £		*Nominal* £	£
5,580	2½% Consols (Guy Bequest)	10,528	5,580
1,185	2½% Consols	2,237	1,185
1,324	3½% Conversion Loan	1,865	1,324
490	3½% War Loan	500	490
1,486	3% Savings Bonds, 1955–65	1,487	1,486
2,992	3% Savings Bonds, 1965–75	2,970	2,992
2,000	3% Defence Bonds	2,000	2,000
100	British Transport 3% Guaranteed Stock, 1978–88	195	100
£15,157			£15,157
	Building Fund:		
£1,380	3½% Conversion Loan	1,522	£1,432
	1950 Benefaction Sinking Fund:		
—	British Electricity 3½% Guaranteed Stock, 1976–79	238	£212
	1950 Benefaction Fund:		
£30,784	*2½% Funding Loan, 1956–61*		
—	British Electricity 3½% Guaranteed Stock, 1976–79	17,075	£15,249
	Frances Wood Memorial Fund:		—
£300	British Transport 3% Guaranteed Stock, 1978–88	513	£300

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

PROCEEDINGS OF THE ONE HUNDRED AND NINETEENTH ANNUAL GENERAL MEETING OF THE ROYAL STATISTICAL SOCIETY, held at the London School of Hygiene and Tropical Medicine on Wednesday, June 24th, 1953.

The Chair was taken by the President, Professor Sir Ronald Fisher, F.R.S.

The President presented the Report of the Council for the financial year 1952 and the session 1952–53, and moved that it be received.

During his submission of the Report the President presented the Guy Medal in gold to Professor A. Bradford Hill, and the Guy Medal in silver to Dr. J. O. Irwin.

He also presented Certificates to the successful candidates in the 1953 examination who were able to be present at the meeting.

The Honorary Treasurer, Mr. R. F. Fowler, presented the accounts and seconded the motion that the Report be received.

A discussion followed in which Professor Kendall, Mr. Stuart, Mr. Leggatt and Mr. Leak spoke.

On being put to the meeting the Report was formally received.

On the proposal of Mr. L. H. C. Tippett, seconded by Dr. W. R. Buckland, Sir Alan Rae Smith was unanimously re-elected Auditor of the Society for the session 1953–54, at a fee of thirty-five guineas.

The President announced that as no alternative nominations had been received, the President, Council and Officers for the session 1953–54, nominated as shown on the list already circulated, were duly elected.

The meeting then terminated.

The Annual General Meeting was preceded by an Ordinary Meeting at which the candidates named below were elected Fellows of the Society:

T. Choudhury.
Geoffrey Mallin Clarke.
George Angus Coutie.
Herbert Aron David.
Mary Joy Fereday.
Arthur Eric Hampson.
David Willmott Livingstone.
Albert Ernest Maxwell.
John Richard Denis Olver.
G. F. Peaker.
John Sidney Seager.
Sydney Anstey Smith-Gavine.
Anthony Warrington.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Regulations of the Study Circle on Medical Statistics

The detailed regulations for the conduct of the Study Circle on Medical Statistics have been approved by the Council, as follows:

ORGANIZATION

1. The Study Circle on Medical Statistics shall be constituted as part of the Study Section in accordance with Regulations 10(*a*) and 10(*b*) of the Study Section (see this *Journal*, Vol. CX, Part I, 1947, p. 70). The Session shall be from July 1st of one year to June 30th of the following year.

MEMBERSHIP

2. Membership of the Study Circle shall be confined to Fellows of the Royal Statistical Society and to members of the Study Section. Persons other than Fellows of the Society wishing to join the Study Circle must therefore apply for membership of the Study Section in accordance with Regulation 2 of that Section.

CIRCLE COMMITTEE

3. Subject to these regulations the affairs of the Study Circle shall be directed by a Committee consisting of 1 Fellow nominated by the Committee of the Study Section and 4 members of the Study Circle elected at the Annual General Meeting of the Study Circle. In the event of any member of the Committee ceasing to be available during a particular session, the Committee may co-opt a substitute who shall hold office until the end of that Session.

4. At least one of the elected members shall retire annually and shall not be eligible for re-election for the period of one year. No elected member may serve continuously as such on the Committee for more than 4 years.

5. The Committee of the Study Circle shall nominate members for election to the Committee for the following Session and these nominations shall be circulated to all members at least one month in advance of the day of the Annual General Meeting of the Study Circle in the current Session. One of the Council's representatives on the Study Section Committee shall be selected by that Committee to serve as an ex officio member on the Circle Committee. Members of the Section may nominate further candidates for election in which case a ballot shall be taken at the Annual General Meeting. Candidates so nominated must be proposed and seconded by members of the Study Circle and nominations must be received in writing by the Secretary of the Study Circle at least a week before the day of the Annual General Meeting.

6. The Committee of the Study Circle shall elect a Chairman and Secretary. A member of the Committee shall be elected to represent the Study Circle on the Committee of the Study Section.

7. The Committee shall arrange meetings of the Study Circle for the reading of papers, discussions or the study of particular problems and may require speakers to submit abstracts of their papers.

8. Each year during the first month of their holding office the Study Circle Committee shall send to the Secretary of the Study Section an estimate of expenditure for the forthcoming Session. A detailed Statement (with vouchers) of expenditure in the past Session shall be forwarded to the Secretary of the Study Section within a month of the end of the Session.

9. A report of the activities of the Circle covering the period since the last report shall be sent to the Secretary of the Study Section not later than March 31st in each year.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—*Quenouille* (*M. H.*). The Design and Analysis of Experiment	453
2.—*Doob* (*J. L.*). Stochastic Processes	454
3.—*Milne* (*W. E.*). Numerical Solution of Differential Equations	456
4.—*Stoll* (*R. R.*). Linear Algebra and Matrix Theory	457
5.—*Bliss* (*C. I.*). The Statistics of Bioassay	459
6.—*Brooks* (*C. F. P.*) & *Carruthers* (*N.*). Handbook of Statistical Methods in Meteorology	460
7.—*Clark* (*C. E.*). An Introduction to Statistics	461
8.—*Cattell* (*R. B.*). Factor Analysis	462
9.—National Bureau of Standards. Tables of Chebyshev Polynomials $S_n(x)$ and $C_n x$; Tables of the Bessel Functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$, $0 \leqslant x \leqslant 1$; Tables of Bessel-Clifford Functions of Orders Zero and One	463
10.—*Booth* (*A. D.*) & *Booth* (*K. H. V.*). Automatic Digital Calculators	464
11.—*Gore* (*W. L.*). Statistical Methods for Chemical Experimentation	464
12.—*Curtis* (*C. R.*). Statistics as Applied to Accounting Data	465
13.—*Kuznets* (*S.*) & *Jenks* (*E.*). Shares of Upper Income Groups in Income and Savings	465
14.—*Hurstfield* (*J.*). The Control of Raw Materials	466
15.—*Nurkse* (*R.*). Problems of Capital Formation in Underdeveloped Countries	467

1.—*The Design and Analysis of Experiment.* By M. H. Quenouille. London: Griffin, 1953. xiii + 356 pp. 9″. 36*s*.

To say that Mr. Quenouille's new book was one of the best in its field would be faint praise, in view of the remarkable lack of textbooks on experimental design. Only six are listed in the present book's bibliography; one more has appeared, presumably too late for inclusion, and two might better have been omitted. Without attempting comparisons, then, let it be said that Quenouille's book is a first-rate one, that it contains a good deal of most useful material not easily available elsewhere, and that it should become a standard work (even if the title does appear somewhat eccentric). The only general criticism of substance is that the chapters have been fitted into a rather Procrustean scheme of four sections, dealing successively with elementary principles and designs, incomplete block designs, long-term policy, and experimental complications, with the result that a good deal of simple material (such as missing plot techniques and variate transformations) is encountered later than the deeper complexities of partial confounding and long-term experiments. Most experimental workers should find the book extremely useful; but they would do well to skip with determination passages they find obscure at a first reading, and to keep a professional statistician handy to elucidate the more difficult sections.

Section A deals with randomized blocks and Latin squares, factorial and split-plot designs. There is an excellent treatment of the breaking down of overall treatment comparisons into individual contrasts. Section B, on incomplete block designs, is mostly devoted to confounding and fractional replication, both of which are described in detail. One chapter discusses rather briefly the various lattice and balanced incomplete block designs, without going into details of the analysis; it would have been better here to refer the reader to the full description in Cochran and Cox's *Experimental Designs* rather than to the original papers, some of which are not easily accessible. Section C, on long-term policy, is undoubtedly the most interesting to the statistician, since it is practically the first adequate treatment of a subject of great importance. A wide variety of designs are given for long-term experiments estimating residual effects, many of them of considerable ingenuity. There is an excellent chapter on the planning of groups of experiments, and another on the combination of experimental results. A section on rotation experiments has for some reason found its way into a later chapter. It is perhaps a pity that the discussion is largely in terms of agricultural experiments on field crops; animal experiments present many analogous features, but they have their own problems which might well have been discussed. There seems to be no

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

mention of the very simple case in which the experimental units receive the same treatment throughout, a case which arises with some animal experiments and with trials on perennial plants. The device of using linear combinations of the serial readings in a short-term type of analysis is useful here and has interesting connections with randomization theory, another topic on which more might have been said. The last section, on experimental complications, starts with a chapter on various special designs and analyses, followed by chapters on missing observations and on problems of scaling. There is a full (if rather uncritical) bibliography, tables of t, F, χ^2 and of random permutations, and an index.

One merit of this book is clearly the amount of ground covered. Another is the very practical flavour which is evident throughout. Not one of the examples is "obtained by randomizing the design on to a uniformity trial"—in fact, as usual in Quenouille's work, the examples have an air of realism conspicuously absent from many statistical texts. The fact that comparative experiments are almost always needed to provide estimates rather than tests of significance is firmly held in mind, and there are few places where the statistics have taken charge to the detriment of the biology. One of these occurs in the recommendation to use a discriminant technique to obtain a single index of treatment effect when several measurements are made on each experimental unit. This has always seemed to me the sort of thing against which the anti-statistical research worker can reasonably complain.

The standard of production is high, as we expect from Messrs. Griffin's excellent series of statistical books, and there are only a few minor errors and misprints. On p. 170 a triple lattice is referred to as a cubic lattice and, owing to a misprint, it is implied that orthogonal squares of sides 14 and 15 exist.

M. J. R. HEALY.

2.—*Stochastic Processes*. By J. L. Doob. New York: Wiley. (London: Chapman & Hall), 1953. vii+654 pp. 9″. 80*s*.

In recent years, especially since the Second German War, there has arisen a considerable interest in processes which develop in time or space according to probabilistic laws. These stochastic processes have many fields of application: telephonic engineering, genetics, industrial inspection, to mention only a few; and the number of methods for investigating them has been increasing rapidly. This increase was made possible by the development of a mathematical theory of probability based on the firm mathematical foundations of measure theory. Processes need no longer be studied through distribution functions but through sample sequences, with a consequent gain in understanding of their evolutionary nature. Professor Doob, in this book, has given an exposition of the mathematical side of this development. He has not attempted to consider the rich field of applications of these studies but has written an account of the mathematical theory. That is the most important fact to be understood about this book: it is only the mathematical theory of stochastic processes that is considered. The reader who searches for birth and death processes, congestion processes or random walks will scarcely find them explicitly mentioned, certainly their solution will not be given though some theory may be there under the general title of the type of process to which each belongs: for a birth and death process, for example, he must look under Markov processes, continuous parameter, infinite number of states. He will then have to sort out which, if any, of the results given, can be applied to his problem and then make his own application. Furthermore he will have to be a good mathematician even to understand the content of the theorems. This then is a book of mathematical theories and must be judged as such. Any criticism that it does not include a discussion of specific problems is therefore invalid.

There are twelve chapters, a supplement, an appendix, a bibliography and an index. Chapter I contains the necessary probability background and is assisted by the supplement in which the necessary measure-theoretic results are stated or proved. As mentioned above, this background is the basis of the modern development. The treatment is condensed, though it is not intended as a first text, and without some prior knowledge of the material it is doubtful if it would be intelligible. For the reader with some prior knowledge the collection of the ideas in one place is valuable. As usual a desirable preparation would be to read Kolmogorov, whose book is a minor masterpiece and is worth reading on that account alone. Doob repeatedly emphasizes the connection between probability and measure theory and in doing so produces the reviewer's favourite remark, " 'Expectation' is a semantical obfuscation of 'integral'." This must have been especially inserted for reviewers to quote. "Equal (in pieces)" is another gem.

Chapter II begins with a most obscure treatment of the measurability aspects of a process and continues with a readable account of the principle types of process. Chapter III surprised me at first. Here is an account of almost classical results on sequences of mutually independent random variables. Owing to the independence the process concept is very weak, but logically the

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

study belongs to stochastic processes and the results are parallelled elsewhere in the book, so that their inclusion is justified. Also the proofs are simpler than those heretofore available. The subjects covered are all limit theorems; laws of large numbers, convergence of series, central limit theorem, etc. Stable laws are not discussed; nor is the law of the iterated logarithm. This latter omission is unexpected in view of the law's strong process content. Processes with mutually uncorrelated or orthogonal random variables are dealt with in Chapter IV. This is equivalent to a study of orthogonal functions. The treatment is terse and it is unfortunate that a fundamental theorem (6·1), which takes a page to state, is not proved and its reference only vaguely indicated.

Markov processes occupy Chapters V and VI; discrete and continuous parameter cases respectively. The fundamental limit theorems for Markov chains are proved and applied, still in an abstract manner, to card mixing. Doeblin's theory for continuous states is then developed and laws of large numbers and central limit theorems considered. The Chapman-Kolmogorov equations and Fokker-Planck equation are discussed.

Chapter VIII (100 pages) is the best in the book. Its subject is simply "Martingales". Prepared, by the dictionary, for a discussion of horses' harness or the rigging of sailing ships I ultimately learned that a martingale referred originally to a gambling system. Doob uses it to mean a process $\{x_n\}$ for which

$$\mathscr{E}(x_n \mid x_1, x_2, \ldots x_{n-1}) = x_{n-1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (*)$$

Strictly a martingale is a generalization of the idea here. Interpreting x_n as the capital of a gambler after the nth play of a game, (*) expresses the fact that the average capital after the nth play, with full knowledge of the preceding gains and losses, is the capital he started with before the nth play, i.e., the game is "fair." Semi-martingales are also considered where the equality in (*) is replaced by "$\geqslant$", corresponding to advantageous games. The first group of theorems about martingales show that a martingale remains a martingale under optional stopping, sampling or skipping, i.e., outside cheating a successful gambling system is impossible. Several inequalities and convergence theorems lead to a section which makes one feel that everything is a martingale, just as everything is a semi-group. Certainly the extent of those processes which can be adapted to be martingales, and therefore to which the martingale results can be applied, is very wide, and includes the study of sequential analysis and likelihood ratios. (The real application is left to the reader here and I doubt if anything new has yet been produced in this connection by martingale theory, however the grouping of apparently dissimilar ideas under a single concept is of value.)

A feature of the book is the duality between strict and wide sense properties. If a process has a property P expressed in terms of variances and covariances and if the Gaussian process with the same variances and covariances has a *corresponding* but stronger property P' then P is a wide sense and P' a strict sense property. Thus convergence in mean square is a wide sense property: almost certain convergence, a corresponding strict sense property. This duality is valuable, though it can cause confusion because a process with a strict sense property may not have the wide sense property; the Markov property is an example. The snag lies in the word "corresponding." Chapter VIII is concerned with processes with independent increments, being the strict sense version of Chapters IV and IX on orthogonal functions (i.e., discrete parameter) and processes with orthogonal increments (continuous parameter). The Brownian and Poisson processes are discussed here, the connection with infinitely divisible laws is investigated and in the wide sense investigations stochastic integral, Campbell's theorem and Fourier transforms find mention.

Chapters X and XI are twins, about stationary processes: discrete and continuous parameter respectively. Particularly welcome here is the connection with measure-preserving transformations, which is discussed at length. There is an admirable section on spectral representation. The book concludes with a valuable chapter on linear least-squares prediction. This is practically the only statistical (i.e., inferential) problem discussed.

The interesting appendix contains notes on the historical development, ascribes results to their discoverers and contains a few hints of other material. The bibliography is rather incomplete and does not even include all the papers mentioned in the appendix. The index is totally inadequate occupying only four pages. There is no adequate table of contents.

The student of the mathematical theory of stochastic processes is well served by this book. It is very useful to have such an able presentation of material which has previously been accessible only in journals and often in a foreign language. The mathematical treatment is masterly and the extent astonishing, even if it only shows how ignorant one was. The major defect is explained by the author in his preface: "it stresses most those parts which appeal most to me". The result of this attitude is a lack of purpose. In chapter after chapter a new type of process is introduced and very skilfully investigated; largely because the mathematics is beautiful? This is a book of mathematically interesting theorems, not a book of solutions to problems. Thus the theory

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

of Markov chains is discussed and the properties of $\lim_{n\to\infty} p_{ij}^{(n)}=p_j$ obtained, but it is never mentioned how p_j is found (the matrix solution proffered is not practicable). Thus without some other material the book is rather uninteresting unless mathematical manipulation for its own sake exerts enough of an appeal. The mathematics makes difficult reading. This results from a desire to make everything completely accurate and as general as possible; consequently any argument contains material which is nothing more than mathematical elaboration and obscures the basic ideas; for example, the use of "Borel sets and also of sets which differ from Borel sets by sets which are subsets of Borel sets of probability 0". It took the reviewer a long time to understand many of the arguments: in retrospect the arguments are clear, though not elegant, but at first attempt it is not possible to see the structure and one has to exist from line to line. Any explanation is offered almost apologetically, thus, "This is, of course, a rough statement which is only intended to suggest the motivation for the discussion to be given". The result is arguments which are difficult to follow but which are indubitably worth following. (The reviewer would like to make it clear that with such a large book, making such difficult reading, the above judgments are based on a sample only and may not be true generally.)

In some cases it is not clear to the reviewer what the mathematical fuss is about. For example in the discussion as early as page 3 the possibility of several models arises. The reviewer has always thought of Ω as the space of experiments: any $\omega\varepsilon\Omega$ is an experiment and could refer to any information about the experiment. A function $\varphi(\omega)$ is all the information that the experimenter is concerned with, and φ almost always takes values in Euclidian n-dimensional space. The measure in this space is usually dictated by the nature of the observations. In other words a closer touch with the practical stimulus for the mathematical treatment may lead to a simplicity in the mathematics. The arguments are made more difficult by the lack of an adequate index, particularly to definitions and symbols, which makes skipping parts in order to read about those topics which interest one a matter of much thumbing of pages to find what a particular term means. Professor Doob is very precise in his terminology and a misunderstanding of this precision can lead one astray.

Here then, is a book which every person interested in stochastic processes and with the necessary mathematical ability will find indispensable. He will also find it difficult but very well worth persevering with and understanding.

D. V. LINDLEY.

3.—*Numerical Solution of Differential Equations.* By W. E. Milne. New York: Wiley (London: Chapman & Hall), 1953. xl + 275 pp. 9″. 52*s*.

Although practical statisticians have few occasions to solve differential equations, many of them act as the tame mathematicians for their establishments, and in this capacity find the problem frequently arising.

The research worker is in a different position. Many sampling distributions can be shown to be the solution of differential equations, and a numerical solution of these is often a practical method of tabulating the distribution. Stochastic processes also lead to partial differential equations, and numerical solution is often the only practical course open. This case is interesting since the partial differential case is often only an approximation to the true solution of the problem, and the numerical technique which gives an approximate solution to the differential equation is an exact solution to the real problem. This interrelation may serve to suggest methods of solution of partial differential equations. It is the basis of the Monte Carlo techniques which are being developed in America.

Even if one has no direct interest in the topic Milne's book is worthy of perusal, since hidden away in various parts of it are devices and hints which are useful to anyone who has need to apply computing techniques in his work.

The book is in two parts dealing respectively with ordinary and partial differential equations. In Part I a wide variety of numerical formulae are given for first order equations, and indications are given of the appropriate circumstances in which to use them. All the methods suggested are illustrated with numerical examples which bring out both the advantages and difficulties of each method.

Consideration of error plays a prominent part in the book, and several derivations of inherited and truncation error, not usually found in the literature, are given. In view of this emphasis on error the dismissal of rounding error, which is often the most serious problem in accurate work, to an appendix is rather curious.

The appendix does give a most ingenious rule for rounding up numbers which completely eliminates the bias associated with the common rule.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The value of graphical solutions to determine the shape of the solution and to predict the regions in which difficulties in the numerical work are likely to arise is under-estimated, since the topic is dismissed in three and a half pages.

The third chapter gives the analytic foundations of the methods used, and lays great stress on Taylor's series expansion and the method of continuation. Picard's iterative process does not receive the same attention, and in the reviewer's opinion this is a pity, since nearly all the formulae quoted or derived are most easily obtained from the integral equation representation of a first order equation.

The Kutta-Runge formulae are given very short mention and dismissed as unsatisfactory since error determination is difficult. Nevertheless, the method has formed the basis of most numerical solutions on automatic machines to date. The book fails to make adquate connection between the method and Taylor's expansion technique. The Kutta-Runge formulae can be regarded as a Taylor's expansion in which the various derivations are evaluated from finite differences in a two-dimensional variate.

Systems of equations and higher order equations are treated fully, and the last chapter in this part outlines the various techniques for dealing with two-point boundary problems. The extension to multi-point boundary problems is not treated.

In spite of the efforts to compare the different techniques suggested, the profusion of methods leaves one at the end of this part without a clear-cut picture of how to tackle any given equation. This may be inevitable, since the key to the successful understanding of the subject is practice.

Chapter 8, the first of Part II, deals with the numerical solution of parabolic and hyperbolic partial differential equations, and a fairly complete account is given of our present rather skimpy knowledge on this subject. The method of characteristics popularized lately for hyperbolic equations receives no mention. The difficulties of non-linear boundaries and discontinuities on the boundary are both dealt with.

The next chapter deals with linear equations and matrices, and considers iterative procedures for solving equations and inverting matrices and finding their latent roots. Much of this work is new, developed in recent years at the National Bureau of Standards, and has an interest to statisticians outside the context of this book. It is claimed that these techniques involve less work for high-order systems of equations than the direct methods; the amount of work is stated to rise as n^2 for n equations in n unknowns, while for the direct methods it rises as n^3. This assumes that the same number of iterations are sufficient for the large systems as for the small ones, i.e., that one's initial guess can be as good, in some sense, for large as for small systems.

The tenth chapter deals with elliptic equations, and reduces the problem of the solution of a system of linear equations. Properties of the matrices arising in this approach are derived. Iterative methods are suggested to solve these equations in view of the claim discussed above. The special character of the matrices enables a direct method to be used in which the work also only rises proportional to n^2, and so, in the reviewer's opinion, this suggestion is not necessarily the best or most economical procedure.

Methods of determining the magnitude of error are discussed, and the difficulties associated with curved boundaries and discontinuities on the boundary are indicated.

The last chapter deals with characteristic value problems, and although it is up to date, it only serves to indicate the lack of knowledge about the topic existing today.

The value of a book of this kind cannot be appreciated by merely reading. It is essential to work out examples given in the text and to use the methods suggested in practice to realize its full worth. It serves as a comprehensive reference book, and contains a bibliography of 258 items relevant to the topic.

K. D. TOCHER.

4.—*Linear Algebra and Matrix Theory*. By Robert R. Stoll. New York and London: McGraw Hill, 1952. xv + 272 pp. 9″. 48*s*.

The value of matrix symbolism in mathematical statistical theory is becoming increasingly appreciated. Before attempting an appraisal of the worth to the statistician of any book on the theory of matrices it is necessary to summarize the fields of application of matrices to discover what parts of the theory are useful to him.

The first obvious application is in dealing with problems in the theory of least squares where a matrix formulation enables quite powerful results to be obtained very readily. It is only necessary to use the elementary parts of the theory of matrices and nothing more difficult than the concepts of the rank and inverse of a matrix are required.

Matrix formulation cannot reduce the amount of arithmetic necessary in the application of least squares methods, but it can help to determine what is the minimum amount of arithmetic

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

required, and to investigate the magnitude of errors arising in these arithmetical procedures and to suggest techniques which minimize them. A study of efficient practical methods of solving simultaneous equations and of inverting matrices is essential for any practical statistician, and for the proper appreciation of the differences between the different methods an understanding of the elementary theory of matrices is required.

The theory of multivariate analysis is also enormously simplified by the use of matrix formulation. In this application the deeper theory of canonical reduction of matrices plays an important part. Fortunately the majority of matrices involved can be assumed to have linear elementary divisors (since repeated latent roots will not occur), and so certain of the most difficult parts of the theory can be avoided.

The major practical problems of multivariate analysis involve the determination of latent roots and vectors. For a proper appreciation of the methods used, and in particular for the more modern techniques due to Lancos and other workers in the National Bureau of Standards, the theory of canonical forms is essential.

The various methods of evaluating sampling distributions by utilizing arguments in n-dimensional space are more easily understood if a knowledge of vector spaces can be brought to bear, and this theory is closely associated with that of linear transformations, which in turn are an essential ingredient in the canonical theory of matrices.

The design of experiments makes increasing calls on matrix methods, and utilizes the theory of quadratic forms. In this case the elements dealt with are often not the ordinary numbers but the numbers of modular fields. The theory of groups has played a prominant part in this subject and there are indications that the matrix representation of this theory may become important in the near future.

Finally, the theory of linear stochastic processes is often presented in matrix form, and introduces the elements of matrix calculus as well as the theory of infinite matrices.

Most mathematical statisticians are becoming familiar with the elementary aspects of the theory of matrices, and there are several excellent text-books which deal adequately with these aspects.

The deeper aspects of the subjects involving the various forms of equivalent transformations and canonical representations are not so well treated in the literature. Most accounts deal with these matters as a branch of modern algebra, and although the unifying power of this approach is impressive, and to those with the ability to understand, it gives a complete understanding, it is too difficult and too abstract for the majority of us. On the other hand, those attempts to deal with it by an extension of the arguments used in the elementary part of the theory are forced into such difficult technical detail that a unified picture of the aims and objectives of the theory is lost.

The ideal book would follow the modern algebraic approach, but would relate the general abstract conceptions involved to concrete realizations, so that the motivation of the mathematics and its relation to its applications were made clear. Stoll attempts this in his book, and, although he is not completely successful, the text is certainly in advance of any other the reviewer has seen.

He usually uses two or three dimensional geometric problems as his concrete realizations, and each new concept is introduced by a section of motivation which helps greatly. Although the theory is developed for the abstract elements of any field, those who wish to think of ordinary real numbers are not seriously handicapped by the general formulation.

As in any book on modern algebra, the rapid succession of new definitions and concepts tends to be bewildering, but these are kept down below the normal number, and any further sacrifices would have destroyed the "roundness" of the book and it would not have been possible to unify the different approaches as effectively.

The book first deals with linear equations and their consistency, and shows how to reduce them to a canonical form termed an echelon system, which is a natural extension to a general set of linear equations of the triangular form used in solving a system of n simultaneous equations in n unknowns. This first chapter also contains the definitions of rank and introduces the concept of a field.

The second chapter defines a vector space and develops the concept of bases, dimensionality and equivalent relations. Quotient spaces are introduced.

The marriage of these two topics takes place in Chapter 3, which treats the elementary theory of matrices. It defines and shows the unique existence of an inverse to a non-singular matrix (a square matrix of full rank). The relation of equivalent transformations of a matrix to transformations of a vector space is discussed.

The fourth chapter introduces a determinant as a function of the elements of a matrix which vanishes if and only if the matrix is singular. By imposing the restrictions that it is a linear homogeneous function the normal definition and its properties are established very elegantly. This

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

approach is very valuable, for it makes abundantly clear the irrelevance of determinants in the computation of the inverse of a matrix.

Chapter 5 gives an account of bilinear and quadratic forms and their matrix representation and transformation under congruent transformations. The case of a real field is treated in detail and the concept of signature is introduced.

Chapter 6 deals with linear transformations of a vector space, introduces the concept of a group and develops the necessary theorems to discuss groups of transformations adequately. Singular transformations are considered, and the chapter ends with sections on rings.

Chapter 7 deals with the canonical representation of a linear transformation (or by an established isomorphism, of a square matrix), and introduces the minimal function (more familiar to English readers as a reduced characteristic function), the characteristic equation and the representation as the direct sum of triangular matrices and the reduction of these to Jordan matrices.

Chapter 8 shows how by specialization of the vector space used the concepts of length and angle can be introduced.

The book is not an easy one, but for anyone who has an interest in matrices it will be stimulating, since the approach in many places is new and the new approach usually leads to more elegant proofs. The style of the book is so free-running that the reader will find it necessary constantly to stop himself from reading faster than he can absorb the ideas.

English readers accustomed to multiple suffices may find the use of superfices and the subscript T for transpose a little irritating, but the ability to understand a topic in a new notation is a real test of one's grasp of it.

K. D. TOCHER.

5.—*The Statistics of Bioassay, with Special Reference to the Vitamins.* By C. I. Bliss. New York: Academic Press, 1952. i + 184 pp. 9″. $3.50.

The publication of text-books on particular fields of application of statistical methods is on the whole a post-war phenomenon. It is therefore not surprising that workers in biological assay, one of the most fertile of these fields, should have had to wait until 1948 for the first book solely on the statistical aspects of their subject (that of Emmens), although a number of expository papers were previously available. The publication in 1952 of Finney's comprehensive "Statistical Method in Biological Assay" has now been closely followed by that of the book under review, and comparison between these two books is inevitable. Both are more detailed than Emmens, and Finney is about three times as long as Bliss. Both are intended as handbooks for the practical worker in bio-assay, and although assuming some familiarity with standard statistical techniques, are written primarily in non-mathematical terms and are generous in the provision of worked examples. Bliss, having less space at his command, is not as comprehensive as Finney, and his style is rather more compressed.

Dr. Bliss's book is reprinted, with a few alterations and additions, from an earlier publication, "Vitamin Methods," of which it formed one chapter. The original pagination is retained, and there are occasional references to diagrams appearing earlier in the original volume and not available in the present reprint. These restrictions are unimportant, and the exposition loses virtually nothing by being confined to vitamin assays, since the methods used in this field have quite general application. The book opens with a short introduction to the general principles of biological assay. The next section, dealing with the dosage-response curve, introduces standard regression methods. A curious feature appearing here and throughout the book is the use of formulae for standard errors of ratios which involve the percentile of the t-distribution at the particular level of significance in which one is interested. The object of this device is to provide a better approximation to the exact fiducial limits than does the usual formula for the standard error of a ratio; even so, the proposed formula does not give the correct length of fiducial interval, and there is an apparent suggestion on p. 505 that a formula for a standard error incorporating the 0·05 or 0·01 level of t can be used to provide $\pm$ one standard error limits if these should be required.

A short section on randomized block and Latin square designs is followed by a long and particularly good section on the estimation of relative potency and of its precision. Features of interest here are the use of orthogonal coefficients for the isolation of single degrees of freedom, the description of various designs in which the important dose contrasts are made within litters, but differences between slopes are confounded with litters, and the estimation of a standard deviation from a mean range (no indication seems to be given that if this method of estimation is used, the effective number of degrees of freedom in a t-test is reduced). A rather confusing feature of this section is that *mean squares* in analyses of variance are usually given this title, but in the analyses where orthogonal coefficients are used they are called *variances*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

A short section on the analysis of covariance introduces an unusual approximation for the fiducial limits of the potency-ratio, involving the "corrected" sums of squares for treatments and slope as obtained in the orthodox analysis of covariance significance test. There is a useful section on assays where the variation in response is a function of the dose, including a brief treatment of probit analysis. A section on slope-ratio assays introduces general formulae for the fitting of lines and estimation of potency in balanced assays (those in which doses are spaced equally and similarly for all treatments with a constant number of replicates at each dose of the unknowns, a different constant number for the standard, and a different number for the negative control). The last section of the main part of the book deals with the analysis of multiple or repeated assays. The methods proposed for the combination of assays seem to raise more problems than they solve. For instance, the methods proposed by W. G. Cochran, which are used here, assume that the error variance of each estimate is distributed as a mean square from a normal distribution, whereas the estimated "variances" of log potency-ratios have more complex distributions and it is doubtful whether they can be assigned the same number of degrees of freedom as the error mean squares in each assay.

In an interesting appendix the author discusses (*a*) Finney's recent suggestion for the analysis of randomized block assays (e.g., those using litter mates), in which he casts some doubt on the applicability of Finney's model, (*b*) the precision of an estimated potency with two error variances (where it should perhaps be mentioned that Fieller's method does not provide an *exact* solution when two different mean squares are involved), and (*c*) relative potency in quantal assays.

There is a most useful glossary, but no tables are provided. The book is handsomely produced. The criticisms mentioned in this review are of a minor nature, and Dr. Bliss's book can be thoroughly recommended as an attractive addition to the literature of bio-assay. P. ARMITAGE.

6.—*Handbook of Statistical Methods in Meteorology*. By C. F. P. Brooks, D.Sc., and N. Carruthers, B.Sc. London: H.M.S.O., 1953. viii + 412 pp. 9½″. 25*s*.

Since the Royal Statistical Society was founded, about a thousand papers have been presented at its meetings; and it is very remarkable how few of them have dealt with that most statistical phenomenon, the weather. The last, I think, was Sir Napier Shaw's on "Seasons in the British Isles" given nearly 50 years ago. Edgeworth, contributing to the discussion on that occasion, pointed out the scope for the application of the theory of errors in meteorology; but it has been left for meteorologists to pursue their own lines of development, occasionally falling into grievous statistical error, without attracting much notice in the annals of the Society.

A book on statistical methods in meteorology—the first of its kind in English—is therefore doubly welcome. This cheap and well printed work has a more than usual authority, being issued by the Meteorological Office of the Air Ministry. Not all the methods advocated in it have the same respectability as its sponsor but this is no matter for regret. On the contrary, it is a very encouraging thing that a Government Department should promote a publication by two of its most devoted employees.

The book falls into three parts. The first two (called the "Distribution of Observations" and "Related Variables") cover univariate and multivariate theory along more or less standard lines, but the background and the exemplification are, of course, meteorological and there is a remarkable wealth of illustrative material incorporated in the examples which I, for one, found a refreshing change from the deaths of insects, the cost of living and the differential effects of fertilizers. Whether this book will teach statistics to meteorologists is not for me to say; it certainly taught a lot of meteorology to a statistician.

Methodologically speaking, the most interesting part of the work is the third, on time-series. To put this in a setting among the developments which have taken place in that subject in other spheres it is necessary to recall something of its history. Many of the data coming to the meteorogist for analysis are undoubtedly influenced by strictly periodic causes such as the rotations of the solar system. It is very natural that he should search for periodicities in the true sense when confronted with an oscillatory phenomenon; and sometimes, as for example with tides, he can find a very good fit to his data by harmonic analysis. He therefore tends to think in terms of harmonic components; the mode of thought finds expression in his terminology, e.g., weather "cycles"; and he abandons a hypothesis of strict periodicity with obvious reluctance.

This tendency to cling to the sine curve has had a marked influence on the development of statistical methods in the study of meteorological time series from the time of Schuster onwards. When recurrences are obviously irregular in amplitude and phase the meteorologist has tried to salvage some of his classical apparatus by the invention of "quasi-periodicities". Both Dr. Brooks and Miss Carruthers have devised methods for bringing out true periodic elements in a series.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The concept of an underlying *distribution* of intervals between peaks or troughs has not yet become an established part of meteorological thought. Until it does so, I think that the analysis of certain kinds of data will be held back; especially those affected by turbulence in the atmosphere such as pressures and rainfall. The true underlying models in such cases are probably a mixture of deterministic and stochastic processes and undoubtedly will prove to be very complicated.

In Part III the authors begin with a chapter on "persistence", that is to say positive serial correlation in time-series. This is discussed in terms of runs and auto-correlations. There follow a chapter on periodicity (defined, I am glad to say, in the strict sense) and two on harmonic analysis and periodograms. The next chapter is on correlograms and similar methods; and the Part closes with chapters on selective methods and a survey. The chapters in this part are short, averaging about nine pages each; and in the comparison of the various methods the authors worked on a series (the constitution of which was sealed in an envelope and unknown while the analysis was proceeding) composed of the sum of a number of strict periodicities and a superposed random component. These comparisons are therefore not conclusive. But it is gratifying that they were made at all.

Owing to the official cachet on this work a reviewer would be justified in being particularly critical of it. But I confess to a strong desire to refrain from harrying pioneers. The important thing is that the authors have produced for the first time a book which surveys the field and gives abundant references. All meteorologists and many statisticians can read it with profit. It should do much to promote improvements in the analysis of meteorological data and to stimulate further work on the theoretical tools required for that analysis.

M. G. KENDALL.

7.—*An Introduction to Statistics.* By C. E. Clark. London: Chapman & Hall (New York: Wiley), 1953. x + 266 pp. 9″. 34*s*.

It is claimed that "this book is a truly elementary introduction to statistics featuring an exposition of statistical inference that can be followed by readers who do not have a mastery of high school algebra." The author is to be commended for realizing that the non-specialist should learn from a book emphasizing the ideas of statistics (which may, indeed, gain by divorce from mathematical encumbrance) and not from books of ready-made recipes which are of little real value despite their superficial "simplicity".

It is a pity that with such an excellent intention there are a number of inadequacies in its execution. Lucidity and precision of exposition are essential in a book of this type, since mathematical symbolism may be used only sparingly as an aid to clarity of thought. There are, unfortunately, a number of pages in this book where arguments of a rather confused kind appear.

On the second page the author introduces the "fundamental notion" of confidence level. Firstly 95 per cent. confidence is stated to mean "correct in *about* 95 per cent. of cases". In the next paragraph it is stated to mean "incorrect in *not more* than 5 out of 100 cases". The position is hardly clarified by the statement, later in the chapter, identifying "confidence" with "probability," since the latter term is not defined until the third chapter, a dozen pages later on. Here there are given three definitions of probability, any one of which, it at first appears, may presumably be used as a confidence level. The three definitions are *empirical* probability, which is equivalent to observed relative frequency, *statistical* probability, which is an estimate of future (or, perhaps, unknown) relative frequency, and *a priori* probability, based on the undefined concept of "equally likely". It is stated (p. 22) that only the first and third of these definitions can apply to a single event. Later, on p. 41, it is stated that "in general, if a statement is made about an event, and if by a success we mean an occurrence of the event for which the statement is true, then the statistical probability of this success is said to be the *probability that the statement is true*". But, according to the author's earlier pronouncement, such a probability *cannot* be a statistical probability since it refers to a single event. This is a typical example of the looseness of expression to be found in the book. Incidentally the sentence last quoted is immediately followed by an example wherein *a priori* "probability that a statement is true" is found. And in the next section confidence is defined in terms of probability that a statement is true.

A further example of misleading and confused argument occurs on p. 178. Following a rather vague analogy between tests of a null hypothesis with the formal logic of proof by *reductio ad absurdum*, it is stated that argument may "reveal that the null hypothesis is false (at some confidence level)". This means (on the author's definition) that the probability that the statement "the null hypothesis is false" is true is at least (or perhaps about—see remarks above) some specific value. It is not at all clear how this fits in with the general theory of testing hypotheses.

Further examples would be tedious. The general atmosphere of the book is equally woolly. The beginner using this book will either be badly puzzled by its inconsistencies, or lulled into a false

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

sense of security with no real understanding of the subject—just the result the author wishes to avoid.

The statistical techniques described include tests for differences between proportions and means, analysis of variance in a one-way classification, the χ^2-test and a purely descriptive treatment of linear correlation. There are many exercises given for the student to work out, and the author has collected a number of interesting sets of data as subject material. Even here, however, there is carelessness in the way some tabular statements are set out, setting a bad example to the student. On p. 147 number of years' teaching experience is classified (with no explanation) into groups 0–3, 4–7, 8–11 and so on. This is rather a surprising lapse by the author, in view of his idiosyncrasy for using class intervals for *all* distributions, even of such variables as the number shown on throwing a die which (p. 45) is assigned class intervals 0·5–1·5, 1·5–2·5, etc. Suffice it to comment that this procedure does not appear remarkable in the setting provided by the text of this book.

N. L. JOHNSON.

8.—*Factor Analysis: an Introduction and Manual for the Psychologist and Social Scientist.* By Raymond B. Cattell. New York: Harper, 1952. xiii+462 pp. 8¼". 48*s*.

In this book there are many items of sound advice for psychologists and social scientists generally. It is, however, a one-track book. There is no objection to that, but only to the claim that no other track is worth following. Those who know R. B. Cattell will be familiar with his extensive and indeed intensive use of factor analysis. Most statisticians would agree that factor analysis may sometimes be a useful tool but few, if any, would agree with Cattell that it was the only analytic tool worth using.

If this book had given a reasonably simple exposition of factor analysis methods and had not launched forth into extravagant claims it might have been a good book. Cattell might almost be said to dismiss the various techniques available in analysis of variance by no more than a gesture. It is not, he says, satisfactory "simply to answer yes or no to the question of whether a change on one variable is associated with a change in another." On the other hand he claims that factor analysis represents a "radical departure from the statistics associated with the experimental tradition in that it does not accept arbitrary choices as to what are the important variables in any field." In this he seems to have failed to understand completely the meaning and use of factorial analysis (analysis of variance).

Although, because of its lack of balance in discussing statistical techniques the book seems hardly suitable as an introduction for undergraduates, it is a very useful comprehensive text for those whose knowledge of statistics is sufficiently advanced to enable them to take or leave the arguments in accordance with their own experience and ideas. The examples should facilitate computations and the mathematically unskilled should be able to follow the routines laid down and to grind out an answer.

Almost all the different systems of factor analysis are explained and very detailed drills given for the arithmetical working. Some interesting graphical methods which seem to be useful time savers in carrying out rotations are discussed. An Appendix covers the essential steps in matrix multiplication by electronic digital calculators. A number of useful hints for those who have to carry out calculations with the minimum of mechanical aids are provided in some 35 pages devoted to the strategy and tactics of economy in computing. In most of this the book is an excellent guide but not, your reviewer considers, when discussing the meaning to be attached to the answers so ascertained.

In this field, where there is still much room for difference of opinion, any review must essentially be based on opinions. In discussing the idea of causation, the rôle of hypotheses, or the principle of the parsimony, there is no way of arriving at an objective approach. Those who find Cattell's ideas of the bases of scientific method to be in keeping with their own would also probably be prepared to follow him through most of his arguments. As those familiar with the literature of factor analysis will be aware, the question "to rotate or not to rotate" is solved at the moment mainly on the basis of nationality. Cattell from his American chair is, perhaps naturally, a rotationist. The idea of rotation is simple enough, and it is only when a large superstructure of philosophy is built upon it that it becomes difficult to find agreement.

Towards the end of the book Cattell introduces what he believes to be some new fields for the application of factor analysis methods and even suggests that there are rare occasions where factor analysis may be used most profitably in conjunction with other methods. He suggests, for example, that economy in factorial analysis (analysis of variance) might be achieved by first carrying out a factor analysis and then proceeding with the artefacts (vectors) so extracted in lieu of the more numerous original variates. Opinions will doubtless differ as to the value of operating

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

with the artefacts but a form of internal canonical analysis might serve to indicate which of a large number of "overlapping" variables it might be most profitable to explore further by means of analysis of variance. A system of this kind was, however, used some four years ago by your reviewer, who made no claim to originality.

As has been suggested above this book might serve a very useful purpose as a guide to the arithmetic of canonical analysis; beyond this its value is debatable. LESLIE T. WILKINS.

9.—*Tables of Chebyshev Polynomials* $S_n(x)$ *and* $C_n(x)$. National Bureau of Standards Applied Mathematics Series, 9. Washington: Government Printing Office, 1952. xxix + 161. 10″. $1.75.

Tables of the Bessel Functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$, $0 \leqslant x \leqslant 1$. National Bureau of Standards Applied Mathematics Series, 25. Washington: Government Printing Office, 1952. ix + 60. 10″. $0.40.

Tables of Bessel-Clifford Functions of Orders Zero and One. National Bureau of Standards Applied Mathematics Series, 28. Washington: Government Printing Office, 1952. ix + 72. 10″. $0.45.

The first of these tables deals with the well-known Chebyshev Polynomials in the particular forms $S_n(x) = 2 \sin \{(n+1) \cos^{-1} (\frac{1}{2}x)\}/\sqrt{(4 - x^2)}$ and $C_n(x) = 2 \cos \{\cos^{-1}(\frac{1}{2}x)\}$. These functions are simple polynomials in x, with alternating positive and negative signs, and with coefficients which are exceedingly simply written down by a continuous summation process on the integers 1, 2, 3, . . . They are written out as far as $S_{12}(x)$ and $C_{12}(x)$ on p. xxvii, and are tabulated from S_2, C_2 to S_{12}, C_{12}. We know in addition that $S_0 = 1$, $C_0 = 2$ and $S_1 = C_1 = x$. The interval in x is 0·001, and the range of tabulation from 0 to 2·000. The functions of order 2, 3 and 4 are exact to 6, 9 and 12 decimal places; thereafter the functions of higher order are uniformly tabulated correct to 12 decimal places. Computation of the Tables was sponsored by the Federal Works Agency, Work Projects Administration, in 1940–42, but they do not appear to have been published until last year. There is a foreword by Dr. J. C. P. Miller, Assistant Director of Research at the Mathematical Laboratory of the University of Cambridge. The introduction proper has been compiled by Cornelius Lanczos, and consists of a very full account of the polynomials in question, including their analytic, algebraic and arithmetical properties.

The second of the tables supersedes the very first of the Applied Mathematics Series, being a re-issue of tables of two of the Bessel Functions, namely Y and K, out of the four extensively tabulated by the British Association Mathematical Tables Committee, and published in 1937. Both are computed for orders zero and unity, and the object was to provide tables for the interval $x = 0$ to $x = 1$ at a much finer interval than given in the B.A. Tables. Following a one-page table of the auxiliary functions related to $Y_0(x)$ and $Y_1(x)$, we find $Y_0(x)$ and $Y_1(x)$ tabled, with differences, to eight decimal places (in some ranges to eight significant figures) for $x = 0{\cdot}0000(0{\cdot}0001)\ 0{\cdot}0500\ (0{\cdot}001)\ 1{\cdot}000$. There follow, prefaced by a table of the auxiliary functions related to $K_0(x)$ and $K_1(x)$, tables of these functions, with differences, to seven significant figures, for $x = 0{\cdot}0000(0{\cdot}0001)\ 0{\cdot}0330(0{\cdot}001)\ 1{\cdot}000$. The tables were prepared by the Computation Laboratory of the National Applied Mathematics Laboratories, under the supervision of Dr. A. N. Lowan, and their re-issue coincides with the re-issue, under the auspices of the Royal Society Mathematical Tables Committee, of the B.A. Table of Bessel Functions, Part I, which was timed to coincide with the very extensive Table of Bessel Functions, Part II, issued in 1952. A preface, foreword and short introduction are supplied with the tables under review.

The third set of tables deals with functions which, although obtainable from existing tables of Bessel functions, cannot so be obtained without laborious computation. Their separate tabulation is, therefore, a service to the user. The functions tabulated are:

I. $J_0(2\sqrt{x})$ to eight decimal places for x ranging from 0 to 410, with interval increasing throughout the range of x from 0·02 to unity; and $J_1(2\sqrt{x})/\sqrt{x}$ to 9 decimal places with the same range and interval; second differences (modified where necessary) are provided.

II. $Y_0(2\sqrt{x})$ and $Y_1(2\sqrt{x})/\sqrt{x}$ to eight and nine decimal places, with second differences, over the same range and interval as in I.

III. $I_0(2\sqrt{x})$ and $I_1(2\sqrt{x})/\sqrt{x}$ to seven decimal places (eight for I_0 to $x = 1$) for x ranging from 0 to 6·2, with interval increasing from 0·02 to 0·05, and with second differences.

IV. $e^{-2\sqrt{x}} I_0(2\sqrt{x})$ and $e^{-2\sqrt{x}} I_1(2\sqrt{x})/\sqrt{x}$ to eight and nine decimal places for x ranging from 6·2 to 410, with second differences.

V. $K_0(2\sqrt{x})$ and $K_1(2\sqrt{x})/\sqrt{x}$ to seven, eight or nine decimal places, with even differences, for x ranging from 0 to 6·2 by intervals of 0·02 or 0·05.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

VI. $e^{2\sqrt{x}}K_0(2\sqrt{x})$ and $e^{2\sqrt{x}}K_1(2\sqrt{x})/\sqrt{x}$ to eight and nine decimal places for x ranging from 6·2 to 410, with even differences.

Three pages of auxiliary tables follow. Preparation of the tables was partly sponsored by the Flight Research Laboratory, Wright Air Development Center, United States Air Force. An introduction, by Milton Abramowitz, describes the mathematical properties of the functions, and illustrates their applications. J. WISHART.

10.—*Automatic Digital Calculators.* By A. D. Booth and K. H. V. Booth. London: Butterworth's Scientific Publications, 1953. vii + 231 pp. $8\frac{3}{4}''$. 32*s*.

This book is an introduction to the design, construction, and use of automatic digital computors. In the early chapters the historical development of digital computors is described and an account given of the logical design of a computor and its main components. The engineering devices which have been or may be used for the construction of these components are discussed in more detail in Chapters 8–12. The last part of the book is devoted to an introduction to the use of machines and to the problems of coding. Some examples of programming with the two-address code of A.P.E.(X.)C. both with and without optimum coding are worked. The final chapter gives an outline of some of the less common applications of automatic computors. A classified and cross-referenced bibliography is included before name and subject indices.

As a first introduction to the subject of automatic computing, engineers will find the book easier than mathematicians; the latter will perhaps find it preferable to read the chapters on coding (Chapters 13–17) immediately after Chapter 4. This book can also be recommended to those who have used one machine and require to familiarize themselves with others; it will be found useful too by both builders and users of computors for the account it gives of each other's difficulties and requirements. Statisticians will be interested principally in the use rather than the construction of computors; from this point of view it is to be regretted that space has not been found for more examples of programming with a single address code and for a lengthier account of numerical methods peculiarly appropriate to high-speed computing.

The authors have a style that is in the main clear and easy to read but some criticisms can be made on points of detail. At the foot of p. 44 the notation a_n, b_n, is used for the nth digit of binary numbers A and B respectively; twelve lines later a_n, not having been used, is redefined and used in a proof with b_n which, without mention, retains its original definition. Three pages later two notations for the pth digit of a number are used and on p. 148 A(1) is used for the first digit of A without being defined. Again, on p. 185 the letter n is used in two different senses without comment. It is not explained why in the typical order shown on p. 27 two separate groups of four binary digits instead of one group of eight are used to specify a memory location.

The printing is clear and attractive; a minor defect is that too large a type is used for numerals occurring as indices or suffices; this is especially noticeable where letters also occur with the numerals (e.g., p. 48).

In spite of these criticisms this book will be found useful by many in the field of automatic computing and it is welcome on that account. E. S. PAGE.

11.—*Statistical Methods for Chemical Experimentation.* By W. L. Gore. New York and London: Interscience Publishers, 1952. xi + 210 pp. 7″. $3.50.

Agriculturists, botanists, biologists, psychologists, etc., probably realize early in their careers the need for statistical methods in the design and interpretation of their experiments. This realization has existed for several decades, and such specialists are fairly well supplied with straightforward expositions of the statistical methods applicable to their particular fields of investigation. The chemist and physicist, however, concerned as they are with the so-called "exact" sciences, are much less inclined to appreciate the need for statistical tools in the examination of their results. The orthodox chemist, even today, has difficulty in understanding the statistical concept of "error". The suggestion that the extent to which his results vary may be a subject worthy of examination is often taken as an affront, implying that he is inefficient in his particular field.

This book, written in a straightforward, easily comprehensible style, should do much to help the chemist and physicist (and more particularly the chemical engineer, for whom it is specifically written) who has decided that the use of the statistical tool may be worth while. Perhaps rather more preliminary spade-work should have been done in the early chapters to persuade chemists and others, that such tools are essential. Mr. Gore states in his preface, "It is my belief that a knowledge of the mathematics of probability is not a requisite for the successful application of

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

statistical techniques, though a fundamental understanding of the philosophic logic and practical limitations is a *sine qua non*"; the mathematics of probability are certainly ignored in this book—perhaps rather more space should have been given to a discussion of the logic behind the use of statistical techniques and to their practical limitations.

This small book packs into its 182 pages all the more usual statistical tests, and gives in appendix "A" tables of Normal Distribution Areas of Student's "t", of χ^2, of the "F" Distribution and of the correlation coefficient. These are followed by an innovation in appendix "B", where the formulae for the various statistical parameters and functions are given with references to the chapter concerned in the body of the book. This idea might well supplement an index in a book written for statisticians, but a non-statistician is surely unlikely to be intimate with such formulae.

This appendix is followed by a rather inadequate glossary where further formulae are given without any real explanation of the meaning of the terms used; in fact "glossary" is a misnomer; it would have been better to have headed this section "Formulae". The Bibliography is short, but includes most of the references likely to be useful to the non-specialist statistician working on chemical experimentation.

As far as the text itself is concerned, it is probably essential in a book of this kind to touch upon the technique of Analysis of Variance fairly early in the proceedings, but it is not clear that when writing for non-specialists it is wise to put the Design of Experiments after the Analysis of Variance, because it is so vital for the experimenter to appreciate that it is on the design of his experiment that much of the value of the ultimate statistical analysis depends.

This book can be recommended to anyone wanting to offer a chemist or chemical engineer a pocket guide to the statistical techniques available. It is doubtful whether it is quite full enough for anyone who, without previous knowledge, wishes to apply these techniques.

S. V. CUNLIFFE.

12.—*Statistics as Applied to Accounting Data.* By C. R. Curtis. London: Sweet and Maxwell, 1953. 2 p.l., 156 pp. $9\frac{3}{4}''$. 22*s.* 6*d.*

Mr. Curtis is probably well advised to avoid advanced methods, which are seldom applicable to accounting data, but as he tries also to avoid technical terms his explanations are usually on a lower plane than is necessary for professional accountants. It is admittedly difficult to find suitable frequency distributions of accounting data, but those given as examples in this book could be improved. For example, a frequency distribution of wages is given with class intervals of 15*s.* only in each range of £1 and then accumulated to calculate the median. The mode is introduced as the largest heading in a sales analysis by attributes. Two series of profits over 9 years have their respective standard deviations and coefficients of dispersion calculated, when such work would be unnecessary if there were figures of turnover or capital employed. Time series are not frequency distributions, and this kind of example will tend to confuse the reader.

Chapter 4 deals with correlation of time series, and endeavours to explain the Pearsonian coefficient with examples and a convenient table of the meaning of each range of values, but without an adequate warning against the spurious correlation often associated with time series. Orthodox methods of extracting trend and seasonal variations are covered, and a section on graphic presentation contains a large number of isolated diagrams and explains the use of semi-logarithmic charts.

The reviewer felt that the chapter on Sampling and Index Numbers could usefully have been lengthened, having regard to current problems such as the revaluation of assets and the elimination of material price fluctuations from accounting results. There appears to be no reference in the book to the use of financial and operating ratios when studying accounts: there is a passing reference to historical records of actual costs, but none to such applications of statistical method as the use of elementary regression analysis in calculating for standard cost purposes the relative incidence of overheads at different budgeted levels of activity. The list of external sources is by no means complete (for the United Kingdom), but there is a full example of a market research inquiry.

The book does not seem to be suitable for class use as there are no examples for the student to work. The detailed worked examples may be useful for reference although the pitfalls may not always be appreciated in the absence of full theoretical justification. One is disappointed that a volume which calls upon the accountant to advance his techniques in its opening paragraph, and which is apparently intended for world-wide circulation, does not contain a little more substance.

HAROLD GEARING.

13.—*Shares of Upper Income Groups in Income and Savings.* By Simon Kuznets and Elizabeth Jenks. New York: National Bureau of Economic Research, 1953. xli + 725 pp. 9″. $9.

This book presents the full results of Professor Kuznets's investigation into the distribution of incomes and savings in the United States, a summary version of which appeared in 1950 as

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Occasional Paper 35 (National Bureau of Economic Research). The inquiry had as its aim the measurement of the level and the changes in the share of personal incomes and savings of the upper income groups who were defined as the top 5 per cent. of the population when ranked according to income per capita. The inquiry was restricted to this relatively narrow section of the population only because of the limitations of the basic source material, viz., federal income tax returns.

The inquiry covers the period 1913 to 1948, and for each of these years estimates were constructed of the shares of the upper income groups in total personal incomes (defined in several different ways), in the various types of personal incomes (e.g., employee compensation, rent, dividends, etc.), and in total savings. During the inter-war period the top 1 per cent. of the population received 15 per cent. of total personal incomes, while the share of the top 5 per cent. as a whole was 30 per cent. During the period 1919–1939 the share of the upper income groups fluctuated within only narrow limits, but since 1939 there was a striking decline in their share—from 28 per cent. in 1939 to 20 per cent. in 1946. Although the shares of these groups fluctuated within narrow limits during the inter-war period they tended to decline during periods of business expansion and rise during periods of contraction. Savings appear to take a fairly stable proportion of the income of the top 5 per cent. of the population, and Professor Kuznets concludes that their share in total savings declines during periods of expansion and rises during periods of contraction. This "counter-cyclical" movement for the upper income groups is in contrast with the overall ratio of personal savings to incomes which are positively correlated. The extreme variability of the savings : incomes ratio for the total population thus appears to be due to violent changes in the ratio for the lower income groups (i.e., the other 95 per cent. of the population).

The book is divided into five more or less independent parts. Part I is devoted to the shares of the upper income groups in total personal incomes and in the various types of incomes. Part II is concerned with the characteristics of the upper income groups as revealed by various sample surveys. This section is not particularly illuminating. The reader interested in the main findings of the inquiry is advised to postpone reading this section until he has read the more important Part III, which is devoted to the relation of personal incomes and savings of the upper income groups and their share in total personal savings as indicated by various sample surveys. Part IV of the book deals with the nature of the basic data, how the estimates were derived and how they were adjusted to the way best suited to the inquiry. It also contains a chapter on the reliability of the estimates. Part V consists of nearly 200 pages of basic reference tables.

The study is based primarily on federal income tax data, which do not lend themselves readily to analysis, hence many detailed adjustments had to be made to the basic data in order to convert the income unit and the income to the most suitable definition, and the greater part of the book is directed to describing, discussing and justifying the assumptions and methods used. In addition to the basic reference tables, which extend over nearly 200 pages, there are 110 tables, 26 charts and several statistical appendices, all of which provide a wealth of information making the book an indispensable source of reference for the research worker in this field. L. S. BERMAN.

14.—*The Control of Raw Materials.* By J. Hurstfield. London: H.M.S.O. and Longmans, Green, 1953. xv+530 pp. 9½″. 35*s*.

The war historians face a stupendous and perplexing task. There is a terrifying mass of original documents, and there are thousands of people who took part in the performance, each with his own ideas of how, when, and why things happened. How to select from all this evidence and condense the selection into a meaningful history which will be worth reading? All the historians so far, including the author of this latest volume in the War Production series, confine themselves to the Whitehall material, so producing histories which are official in more than one sense. But even with this limitation the material is overwhelming and the task of dealing with it formidable. How much easier it will be for some future historian to rewrite it all when the events can be viewed in dispassionate perspective, when the mice have eaten some of the files, and when none of those who were alive at the time are there to point out the distant connection between what was written on the official files and what actually happened.

Mr. Hurstfield has had a specially difficult task in writing the history of raw materials. For practically every wartime problem had its raw material aspect: munitions production, import and shipping policy, exports, home production and man-power, civilian supplies and rationing, Anglo-American relations, were all inextricably interwoven with issues of raw materials policy and supply. Mr. Hurstfield has attempted to make his task manageable by dealing with this tangle of subjects in four main parts: first, a section on pre-war preparations, including a review of control, both Government and private, of raw materials during the inter-war years which is hardly relevant to the remainder of the book; second, "The Requirements of Raw Materials," dealing in turn with munitions, export and home civilian needs; then, "The Supply of Raw Materials"

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

which comprises the main part of the book. Here we have a detailed treatment for successive periods of import problems and policy with special attention given to Anglo-American supply relations, followed by a discussion of home supply, conservation, costs and prices. Finally there is a Section headed "Conclusion: The Organization of Control," mainly concerned with the manning of the Controls, the respective roles and functions of the Controls and the Raw Materials Division of the Ministry of Supply, and the relations between them.

Each section is a competent summary, lucidly written, and amply peppered with the most important statistics. There are frequent pauses when the reader is asked to sit back and take a general analytical view of some of the problems and issues raised in the mainly narrative sections. Here we get some interesting critical comments on failings in organization and policy. Altogether this is a well-produced book and well worth reading. Yet I felt there was something missing. I started reading the book hoping to get some understanding of how the system of control really operated, but I was disappointed. All the paraphernalia of planning is there—requirements, allocations, priority, designation, preference, plans, programme, co-ordination, the user principle, etc., but they all flit across the pages like phantoms. I got no picture of how they all added up to a workable system for obtaining and distributing raw materials supplies as a substitute for a system based on money and prices.

I think that Mr. Hurstfield has failed to achieve this, indeed perhaps he was not trying to do so, because he attempts to deal with practically every material, import programme and statement of requirements. I should have found it much more enlightening if he had taken one material, say steel, for one period and shown in some detail how the statements of requirements and supplies were built up in the Departments, the arguments that were used by each Department in presenting its case to the Materials Committee, the tussle that went on before an allocation was agreed, and what changes, if any, the Departments had to make in their plans when they knew what had been allocated for the coming period. And if one wanted to show how the system changed, developed and improved as the war went on, why not take a case like this in 1940 and then one in 1943 or 1944 and discuss the differences?

Similarly the story of the complex and ever changing arrangements for Anglo-American supply left me with little impression of what the Combined Boards did and how they did it, except that they were all co-ordinating. An explanation in some detail of what one meeting of one of these Boards did and what effects their decisions had, would have been much more helpful.

I suppose all this amounts to a plea for the use of the case study method when one is attempting to show how an administrative system works. But perhaps it would not be history. If it is not, then the official histories are all going to by-pass one of the most interesting and fascinating aspects of wartime economic experience.

There is one comment I would like to make on the interpretation of events which is common to all the volumes published so far and which Mr. Hurstfield follows. This is the great emphasis that is put on the little that was achieved between September, 1939, and June, 1940, the "phoney war" period, and how everything changed after Dunkirk. I begin to wonder whether the argument is not overdone. In the civilian field one must not forget that the resistance to clothes rationing in the highest quarters was well after Dunkirk. If Mr. Hurstfield had included the figures for 1940 in his Table of per capita consumption in the United Kingdom (p. 125), the reader would have been able to see that by far the biggest proportionate reduction in consumption took place between 1939 and 1940, and he might have found this a little surprising in view of what is said in the text. The official historian's view of the phoney-war period is undoubtedly the fashionable one, but is it not just the kind of fashionable interpretation which historians themselves delight in upsetting? Is not Mr. Hurstfield overdoing it when he refers to the general attitude during the early months of the war as "the first fine careless rapture of that sunny autumn"? (p. 116).

E. DEVONS.

15.—*Problems of Capital Formation in Underdeveloped Countries.* By Ragnar Nurkse. Oxford: Blackwell, 1953. 163 pp. 8½″. 15*s*.

This excellent and extremely readable book throws welcome light upon the subject of the economic advancement of underdeveloped countries, one of to-day's most vital issues. Professor Nurkse deals, in a particularly short space, with the salient components of what he accepts as the centre of this problem—capital formation—in a most competent and, sometimes, novel fashion. Unhappily, there is little in this survey to suggest that a satisfactory solution is at hand or that one may become available in the near future.

Two major limitations reduce the value of this work. In the first place, while it is clearly desirable that a "cobbler should stick to his last", the author may be accused of taking this dictum too seriously. Non-economic considerations are often fundamental to development problems,

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

but Professor Nurkse rests very definitely on his side of the boundary between economics and sociology although, whilst regarding capital as being necessary for economic progress, he admits that alone it is insufficient, as suitable human factors are also required. Capital formation in education, skill and health is not considered; technological aspects are ignored, and financial matters are given only a perfunctory treatment.

Secondly, the author has attempted to survey all the main aspects, subject to the exclusions mentioned above, of capital formation in relation to the development of economically backward areas. To do this in a matter of some one hundred and fifty smallish pages has meant, too frequently, that depth of analysis and development of argument have had to be sacrificed. Whilst this has reduced the immediate practical utility of the volume, it appears certain that it will give direction and impetus to deeper studies in the future. Professor Nurkse would certainly be the first to recognise, particularly in the light of his provisional conclusions, the need for such further analyses.

In essence, this book deals with the inadequate incentives to capital formation which obtain in underdeveloped territories; the possible reservoirs of saving which accompany conditions of underemployment in agricultural communities; the necessity for improving agricultural productivity, and the obstacles to domestic saving in these areas. Consideration is also given to foreign investment, which is dealt with in terms of the factors controlling investment inducements. Stress is laid upon the need for strengthening these inducements, and for the development of suitable domestic policies to ensure that capital inflows are used productively. Commercial policies are regarded as being of very limited value in improving these incentives and for increasing the import of capital goods. From this formidable list of subjects, each of which is treated in a manner that encourages to the full further discussion, it is only possible, in the space available, to give consideration to a few more or less arbitrarily chosen points.

Broadly speaking, Professor Nurkse accepts that the fundamental cause of a country's poverty *is* its poverty. He begins by describing two circles—one on the demand, and one on the supply side—which must be broken if economic development is to take place at an adequate rate. His analysis of the impediments on the commonly neglected demand side is of considerable interest. In order to free a territory from the cramping force of these circles, which impinge at the point of low real incomes arising out of low productivity, the author considers that a "balanced growth" of industry is essential. The smallness of the local market, in his opinion, prevents substantial advancement through investment in a single form of industrial activity, because such a market cannot offer the required incentives (cf. Adam Smith's limitations to the extension of the division of labour). In harmony with Schumpeter's *Theory of Economic Development*, Professor Nurkse concludes that these limitations can only be overcome by a synchronized attack on a wide and diversified front. While it is not difficult to appreciate the advantages to be gained from "balanced growth", it is not so easy to see how, in the near future, it is to be brought about in most underdeveloped areas. The book is not particularly helpful regarding this point.

The position, however, may not be so grave as this suggests. Professor Nurkse has by his delineation of the field of this book, cut himself off from the assistance of non-economic forces. Development basically arises out of a desire for development. The United Nation's report on *Measures for the Economic Development of Underdeveloped Countries* suggests that, while there cannot be rapid economic progress unless the leaders, at all levels, of a nation desire economic development for their country and are willing to pay its price, "the masses take their cue from those who are in authority over them" and "given leadership and the public will to advance, all problems pf economic development are soluble". Are these conditions so rarely to be found ?

It is also the author's contention that valuable as external aid may be it is unlikely to achieve its purpose fully unless domestic resources are also harnessed. His sections dealing with the possible saving potential obtaining in agriculture where conditions of underemployment exist, and the extent to which it can be used to extend the effect of capital inflows, are extremely instructive. He discusses at some length the mobilization of this hidden surplus, and points out that this process might be achieved by changing occupational patterns (consumption being left more or less constant). The author, however, recognizes that strong opposing forces might arise out of the growing awareness in underdeveloped countries of the living standards of more advanced territories (cf. Duesenberry's "demonstration effect"). Conditions were very different during the comparable formative period in Western Europe, and Japan's isolationist policy during its early stages of industrial development is no longer a practical one, even if it were considered desirable, for most underdeveloped areas.

The desirability of marshalling and developing domestic resources, particularly as it is clear that external capital is unlikely to afford a long-term remedy, is obvious, but one feels some hesi-

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

tation in accepting even a temporary "freezing" of consumption as a means to this end. Existing levels may themselves be exerting a depressive effect whilst increased consumption might well strengthen the private capital inducements which are so necessary, and increase productivity generally.

Professor Nurkse does not appear to meet this argument effectively by stating that it is a simpler matter to prevent rises in consumption than to reduce the level as with the former "no hardship is involved except that of foregoing an immediate rise in the level of living in favour of a greater permanent increase in the future". The exception here may, in practice, be too strong an obstacle and may, on efficiency grounds alone, be unjustified. In many cases a policy of "pegging" consumption is one which few would wish to advocate and fewer still to accept in practice.

In face of all the deterrents to an increase in private voluntary saving, Professor Nurkse turns to compulsory saving as an alternative, but in a democratic state pressure for improvements in living conditions may well mean that this forced "saving" is expended on consumption; it may also further reduce the flow of voluntary saving and weaken the "capital consciousness" which the author considers to be so important a by-product of that activity.

Naturally this book has its share of minor defects, some of which may be worth mentioning. It is based largely upon a number of lectures given by the author at various times and places and he has not always been successful in eradicating the influence of this origin. Interesting points are on occasions raised only to be by-passed (e.g., the effect of education on both consumption and capital formation). These lapses may prove irritating at times but they have the advantage that they often provide a stimulus to independent thought. Again, although not affecting the general value of this study, Professor Nurkse's preoccupation with the experience of underdeveloped countries in Latin America and the Middle East reduces somewhat the practical utility of this survey for those mainly concerned with Africa and similar areas.

Professor Nurkse has made a valuable contribution to this field of study and there are few who will not gain by reading this book. That he does not offer an easily attainable or acceptable answer to the problem at issue is not so much a criticism of the author as an indication of the intractability of the subject. A solution will eventually be found—this is a categorical imperative —und undoubtedly that solution will be influenced, directly or indirectly, by this preliminary study.

F. E. RICHMOND.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL NOTES

(1) British Official Statistics

The interim index of retail prices published by the Ministry of Labour and National Service which stood at 140 (prices at June 17th, 1947 = 100) in May, 1953, rose to 141 in June and July and fell back to 140 in August. The rise in June was mainly due to higher prices for certain food items and in particular to seasonal increases in the price of fresh fruit. In July reductions in the prices of some vegetables were offset by increases for milk, potatoes and eggs. Separate figures on the same basis for different groups of commodities are not available, but the following are the figures based on January 15th, 1952 = 100.

Date	*Food*	*Rent and Rates*	*Clothing*	*Fuel and Light*	*House-hold Durable Goods*	*Miscel-laneous Goods*	*Services*	*Alcoholic Drinks*	*Tobacco*	*All Items*
Weights:	399	72	98	66	62	44	91	78	90	1,000
May 12th	112·7	108·4	95·6	104·7	94·9	100·0	107·6	101·0	100·3	106·0
June 16th	113·8	108·5	95·6	105·4	94·8	100·0	108·0	101·0	100·3	106·6
July 14th	113·7	108·7	95·4	105·6	95·2	99·9	108·1	101·4	100·3	106·6
Aug. 18th	111·7	108·8	95·4	105·8	95·2	100·0	109·0	101·4	100·3	105·9

The Ministry of Labour index of weekly wage rates which was 135 (June 30th, 1947 = 100) in May and June rose to 136 in July and August. The workers who received increases in July included employees in printing, furniture making and electricity supply. In August there were increases for agricultural workers, cotton operatives and iron and steel workers.

The six-monthly enquiry into average earnings showed that in April, 1953, the average earnings per week in the industries covered by the enquiries were 185*s.* 11*d.* for men, 100*s.* 3*d.* for women, 77*s.* 7*d.* for youths and boys and 62*s.* 6*d.* for girls. These figures represent increases over October, 1938, of 169, 209, 197 and 238. For all workers combined the average was 157*s.* 7*d.*, 196 per cent. more than in October, 1938. The index for April, 1953, compared with 100 at April, 1947, was 152. This compares with a rate of wages index for the same industries of 136. The average hours worked were 46·2, slightly higher than on October, 1952, and half an hour longer than in April, 1952. In manufacturing industries alone the average earnings in April, 1953, were 191*s.* 11*d.* for men and 101*s.* for women.

The total working population and the numbers in civil employment in the four months ending July were as follows:

Thousands

	Total Working Population			*Numbers in Civil Employment*		
	Males	*Females*	*Total*	*Males*	*Females*	*Total*
April, 1953 . .	15,868	7,441	23,309	14,815	7,295	22,110
May, ,, . .	15,867	7,458	23,325	14,836	7,331	22,167
June, ,, . .	15,862	7,463	23,325	14,841	7,349	22,190
June, ,, . .	15,864	7,488	23,352	14,841	7,373	22,214

The number of persons on the unemployment registers of the Employment Exchanges fell by 42,000 in June, and by 25,000 in July. In August it rose by 20,000, the increase being mainly in boys and girls.

The following is a sex analysis of the figures:

Number of Unemployed Persons on the Registers of Employment Exchanges

Date	*Men and Boys*	*Women and Girls*	*Total*
May 11th	214,263	125,990	340,253
June 15th	193,552	104,190	297,742
July 13th	179,725	92,951	272,676
Aug. 10th	190,913	102,623	293,536

Of the total of 293,536 at August 10th, 11,147 were temporarily stopped, 86,052 had been unemployed for not more than two weeks, 75,090 from two to eight weeks and 121,247 for over eight weeks.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

The numbers of insured persons absent from work owing to sickness, including self-employed as well as employed, were 881,700 in May, 848,500 in June, 816,000 in July and 818,100 in August. The numbers of employees absent owing to industrial injuries were 59,400, 56,400, 58,600 and 57,000.

(2) Other Statistics

The third, and last, volume of the documents from the Third Conference of British Commonwealth Statisticians held at Canberra, Australia, in November 1951 is now available. It covers the papers under the various headings of the agenda contributed by the countries represented at the Conference. It may be noted in passing that the first volume contained a Report of the Proceedings and the second a Summary of the Proceedings. The second volume being issued for those who were prevented from attending the Conference was of limited circulation.

The ninety-four papers are printed under twenty-six sections covering thirteen agenda headings and each section is prefaced by historical notes tracing the line of development from the First Conference of British Empire Statisticians held in London in 1920. The agenda headings were: labour; production; agriculture; minerals; external trade; retail trade; road transport; sampling methods; national income; family budgets; prices; census taking; statistical coordination.

In this substantial foolscap volume is a vast store of information on official economic statistics which would be difficult to obtain through the ordinary channels of literature in the field of economics or statistics.

Although the subsequent development of the Indian National Sample Survey (NSS) has rather outmoded its First Round, *The National Sample Survey: General Report, No. 1 on the First Round, October, 1950–March, 1951* (Dept. of Economic Affairs, Government of India, 1952) describing the initiation, planning and execution of the First Round of the NSS is of interest to sampling practitioners as a case-study in the launching of a large-scale continuing sample project in circumstances of considerable practical difficulty.

The aim of the National Sample Survey is to collect information on a wide variety of economic questions from a multistage sample of households spread over the whole of India, although in the first two rounds only rural areas were included. The extensive previous experience of the Indian Statistical Institute helped to overcome the problems of constructing a sampling frame, and of organizing and supervising a large body of field workers. In later rounds, the availability of 1951 Census data made a new sample design possible.

The problems which have arisen in later rounds of the NSS have been described by Professor Mahalanobis and Dr. Sen in a paper read to the 28th Session of the International Statistical Institute at Rome in September 1953, which will be published as part of the Proceedings of that conference. Read in conjunction with that paper, the report on the First Round deserves the attention of all those concerned with the organization of sample surveys.

The Institute of Statistics of the University of Paris has established "Le Centre de Formation des Ingénieurs et Cadres aux Applications Industrielles de la Statistique" for the purpose of fostering the application of statistics to industry in France. The Centre is arranging two types of courses of instruction, one an elementary course lasting for a period of between ten and fifteen days and designed to teach the principles and practice of statistical quality control, and the other for engineers with some mathematical training, lasting for three weeks and covering a considerable amount of statistical theory as well as sampling and market research.

The organ of the Centre is the *Revue de Statistique Appliquée*, the first number of which has recently appeared. This journal, which is edited by M. E. Morice, aims at presenting concrete examples of the application of statistics to industry, taken from France and abroad, and expositions of statistical methods. The articles in the first number will undoubtedly further the aims of the journal and Centre. We wish this new enterprise every success.

CURRENT NOTE

The Trustees of the Houblon-Norman Fund invite applications for Fellowships or Grants in aid of research into the working of financial and business institutions in Great Britain and elsewhere and the economic conditions affecting them.

Apart from exceptional cases, awards will be confined to British-born subjects normally resident in the United Kingdom and will take effect from October 1st, 1954. Fellowships will be awarded for one year, renewable for a second year: and the amount of an award will depend upon the circumstances of the candidate and the likely expenses of his work.

Applications should be made not later than March 31st 1954, and forms of application may be obtained from the Secretary of the Fund, c/o the Bank of England, London, E.C.2.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

July 1953—The use of statistics in consumer research: *P. Harper*. A flow chart for social accountants: *E. Fuerst*. The mathematics of variance analysis: *G. Amerman*.

British Journal of Preventive and Social Medicine—

July 1953—Differences in the National Health Services of England and Scotland: *I. A. G. Macqueen*. Administrative divisions within the National Health Service: *A. L. Banks*. Health services of Northern Ireland: *A. T. Elder*. Review of 8,000 cases of pneumonia admitted to Dudley Road Hospital, Birmingham (1934–38 and 1944–48): *V. Norris*. Geographical and social variations in the incidence of notified poliomyelitis: *B. Benjamin* and *W. P. B. Logan*. *P*-technique: *R. B. Cattell* and *H. F. V. M. Williams*.

British Journal of Sociology—

June 1953—Scottish religious adherence: *J. Highet*. Business enterprise: traditional symbol of opportunity: *K. Mayer*. The social grading of occupations in Australia: *R. Taft*.

Cambridge Philosophical Society, Proceedings—

April 1953—Micro-programming and the design of the control circuits in an electronic digital computer: *M. V. Wilkes* and *J. B. Stringer*. Some probability limit theorems with statistical applications: *P. H. Diananda*. On the differential equations for the transition probabilities of Markov processes with enumerably many states: *G. E. H. Reuter* and *W. Ledermann*. Recurrence and first passage times: *M. S. Bartlett*. The serial test for sampling numbers and other tests for randomness: *I. J. Good*.

July 1953—On the distribution of queuing times: *W. L. Smith*. A frequency-function form of the central limit theorem: *W. L. Smith*. Stochastic processes associated with random divisions of a line: *A. Ramakrishnan*.

Economica—

August 1953—A new method of relating British capital ownership and estate duty liability to income groups: *A. M. Cartter*.

Institute of Actuaries, Journal—

Vol. LXXIX, Part I, No. 351—New developments in interpolation formulae: *E. Michalup*. Some animal life tables: *J. B. S. Haldane*. The recent trend of mortality in England and Wales: *W. S. Hocking*.

Journal of Documentation—

June 1953—Information theory and clerical systems: *R. A. Fairthorne*.

Oxford Economic Papers—

June 1953—Production costs in the gas industry: *T. K. Gribbin*.

Oxford University Institute of Statistics, Bulletin—

June-July 1953—National survey of personal incomes and savings: *H. F. Lydall*. An index of teachers' salaries: *F. Conway*. A "human needs" diet: April 1953: *T. Schulz*. A note on the use of statistics about savings: *T. K. Gribbin*.

August 1953—Rates and earnings in London Transport: *H. J. D. Cole*. Unemployment in textiles: *H. A. Turner*.

Population Studies—

July 1953—Recent migration from West Africa and the West Indies to the United Kingdom: *M. Banton*. Housing policy and population problems in France: *C. Watson*. Nuptiality, fertility and reproduction in Norway: *P. Ramholt*. Japanese rural fertility: some social and economic factors: *R. P. Dore*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Review of Economic Studies—

Vol. XX (3)—The role of national income estimates in the statistical policy of an underdeveloped area: *D. Seers*. Social security and inflation: a study of the economic effects of an adjustable pensions scheme: *A. T. Peacock*. Trade barriers in activity analysis: *S. Reiter*. The maximization of profit by a newspaper: *W. M. Corden*. On the use of the theory of probability in economics: *R. S. Weckstein*.

UNITED STATES—

American Economic Review—

June 1953—Some notes on multiplier theory: *R. Turvey*. Comparability of labor capacities of farm and non-farm labor: *D. G. Johnson*. Futures trading and hedging: *H. Working*.

American Statistical Association, Journal—

June 1953—Wesley Clair Mitchell: the economic scientist: *A. A. Berle*. The velocity of time deposits: *G. Garvy*. Changes in the functional distribution of income: *J. Burkhead*. The post-enumeration survey of the 1950 Census: a case history in survey design: *E. S. Marks, W. P. Mauldin* and *H. Nisselson*. On the distinction between enumerative and analytic surveys: *W. E. Deming*. Confidence intervals for the number showing a certain characteristic in a population when sampling is without replacement: *L. Katz*. The up-and-down method with small samples: *K. A. Brownlee, J. L. Hodges, Jr.*, and *M. Rosenblatt*. Designing single-sampling inspection plans when the sample size is fixed: *A. Golub*. On errors in the matrix inversion: *P. S. Dwyer* and *F. V. Waugh*. Estimation of the parameters of type III populations from truncated samples: *D. Raj*.

Annals of Mathematical Statistics—

June 1953—On the construction of group divisible incomplete block designs: *R. C. Bose, S. S. Shrikhande* and *K. N. Bhattacharya*. The basic theorems of information theory: *B. McMillan*. On a heuristic method of test construction and its use in multivariate analysis: *S. N. Roy*. On a class of problems related to the random division of an interval: *D. A. Darling*. Sequential decision problems for processes with continuous time parameter. Testing hypotheses: *A. Dvoretzky, J. Kiefer* and *J. Wolfowitz*. Equivalent comparisons of experiments: *D. Blackwell*. Testing one simple hypothesis against another: *L. Weiss*. On the exact evaluation of the variances and covariances of order statistics in samples from the extreme-value distribution: *J. Lieblein*. Generalized hit probabilities with a Gaussian target, II: *D. A. S. Fraser*. A class of minimax tests for one-sided composite hypotheses: *S. G. Allen, Jr.* Note on computation of orthogonal predictors: *B. F. Kimball*. On the asymptotic normality of certain rank order statistics: *M. Dwass*. Note on the variation of means: *C. Goffman*. On Mill's ratio for the type III population: *D. Raj*.

Bell System Technical Journal—

July 1953—System design: *C. H. Elmendorf, R. D. Ehbar, R. H. Klie* and *A. J. Grassman*. Quality control requirements: *H. F. Dodge, B. J. Kinsburg* and *M. K. Kruger*. Application of quality control requirements in the manufacture of components: *R. F. Garrett, T. L. Tuffnell* and *R. A. Waddell*.

Biometrics—

June 1953—The analysis of variation in a natural population of lady beetles: *F. M. Sturtevant, Jr., L. D. Calvin* and *O. Park*. The chain block design: *E. Youden* and *W. S. Connor*. Design and analysis of triangular singly linked blocks: *K. R. Nair*. Split-plot half-plaid squares for irrigation experiments: *W. C. Jacob*. Fitting the negative binomial distribution to biological data and note on the efficient fitting of the negative binomial: *C. I. Bliss* and *R. A. Fisher*. The fitting of multi-hit survival curves: *A. W. Kimball*. Population growth of the sexes: *L. A. Goodman*. Estimation of variance and covariance components: *C. R. Henderson*.

Econometrica—

April 1953—Capital accumulation and efficient allocation of resources: *E. Malinvaud*. L'extension des théories de l'équilibre économique général et du rendement social au cas du

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

risque: *M. Allais.* An axiomatic approach to measurable utility: *I. N. Herstein* and *J. Milnor.* A dynamic model: part 2. Actual model structure and numerical results: *J. L. Holley.* Effects on demand of changes in the distribution of income: *K. Borch.* Four alternative policies to restore balance of payments equilibrium—a comment and an extension: *J. Tinbergen* and *H. M. A. Van der Werff.*

Estadistica—

June 1953—Potencialidades estadísticas del sistema nacional de identificación de Chile: *J. M. Las Heras* and *C. G. Bennett.* Statistics of travel between Canada and other countries: methods and summary results: *C. D. Blyth* and *W. R. Miller.* Los elementos de un sistema de clasificación industrial: *W. R. Simmons.* Utilization of census data in national health activities: *J. T. Marshall.* Utilizacion de los datos censales en la educación: *F. S. Céspedes.* Algunas sugestiones para el mejoramiento y la coordinación en las estadísticas nacionales: *O. A. C. Ayala.* Marriage statistics in the United States: development and current plans: *H. Carter* and *S. Lewit.* Standards for statistical surveys and publications (estándares para investigaciones y publicaciones estadísticas).

Harvard Business Review—

July-August 1953—Operations research for management: *C. C. Herman* and *J. F. Magee.*

Industrial Quality Control—

July 1953—Quality control of visual characteristics in carpet manufacture: *S. E. Lezinski.*

Journal of Political Economy—

August 1953—Choice, chance and the personal distribution of income: *M. Friedman.* On incidence: *R. A. Musgrave.*

Operations Research Society of America, Journal—

May, 1953—Sub-optimization in operations problems: *C. Hitch.* A mathematical note on sub-optimization: *A. W. Marshall.* The theory of value and the science of decision—a summary: *N. M. Smith, Jr., S. S. Walters, F. C. Brooks* and *D. H. Blackwell.* Linear programming and profit preference scheduling for a manufacturing firm: *A. Charnes, W. W. Cooper, D. Farr* and *Staff.* Failure of complex equipment: *G. D. Shellard.* Operations research and the management consultant: *J. W. Pocock.*

Psychometrika—

June 1953—Estimation of the correlation coefficient in the case of a bivariate normal population when one of the variables is dichotomized: *J. S. Maritz.* A simple procedure for rearranging matrices: *W. A. Gibson.* A table for the rapid determination of the tetrachoric correlation coefficient: *M. D. Davidoff* and *H. W. Goheen.* A factor-analytic study of reasoning abilities: *R. F. Green, J. P. Guilford. P. R. Christensen* and *A. L. Comrey.* A method for factoring large numbers of items: *R. J. Wherry* and *B. J. Winer.*

Review of Economics and Statistics—

May 1953—Linear programming: *J. Chipman.*

FRANCE—

Journal de la Société Statistique de Paris—

April-June 1953—Le mouvement brownoïde de l'homme et des animaux: *P. Vendryes* and *R. Malterre.* Les lieux de travail et zones d'habitation du département de la Seine: *L. Flaus.* Application des méthodes statistiques aux problèmes de la gestion des patrimoines immobiliers: *M. Hermitte.*

Revue d'Économie Politique—

May-June 1953—Salaires et inflation depuis la seconde guerre mondiale: *R. Goetz-Giry.* L'Optimum d'investissement: *P. M. Pradel.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

GERMANY—

Mitteilungsblatt für Mathematische Statistik—

Vol. 5, Parts 1/3—Folgetest für die Abnahmeprüfung von Mengen mit grossen und kleinen Stückzahlen: *G. Wagner.* Die Anwendung der statistischen Prüfverfahren auf Reihen mit Erhaltungsneigung und kontinuierliche Gesamtheiten: *H. Giesekus.* Einige Bemerkungen und Ergänzungen zum graphischen Verfahren von Mosteller und Tuckey: *H. Gebelein.* Eine Verallgemeinerung des Verteilungsgesetzes von Rosin-Rammler-Sperling für die Korngrössen fein zerkleinerter Stoffe: *K. Stange.* Statistische Methoden bei Arbeitsstudien: *J. R. de Jong.* Zur Ermittlung der Korngrössenverteilung aus Dünn- und Anschliffen: *H. Münzner.* Dreie neue Hilfsmittel für die praktische Statistik: Sonderschieber für Häufigkeltsrechnung, Häufigkeitsnetze, Stichproben-Kontrollblock: *W. de Beauclair.* Durchlasswahrenseinlichkeit bei Vermittlungseinrichtungen der Fernmeldetechnik: *K. Rohde* and *H. Störmer.* Kurvennetz für die Zufallsergebnisse von Stichproben: *C. Nebel.* Zwei Fluchtlinien Nomogramme: *J. Pawlowski.* Beispiele zur Anwendung statistischer Untersuchungsmethoden in der Industrie: *H. C. Hamaker.*

Weltwirtschaftliches Archiv—

Vol. 70, Part 2—Forest rotation—a contribution to the theory of the optimum investment period: *H. Dickson.* Akzelerationsprinzip und Importneigung: *H. Giersch.* The income surplus theory of capital accumulation: an unfriendly appraisal: *D. Dewey.*

HOLLAND—

Statistica—

Vol. 6, No. 4—Voorspelling en profetie: *D. van Dantzig.* Voorspelling van historische ontwikkelingen: *H. Baudet.* Voorspellen in de toegepaste psychologie: *A. D. de Groot.* Voorspellen van de economische toestand: *L. C. Kuiken.* Voorspellen van het weer: *S. W. Visser.* Voorspellen van waterstanden: *J. P. Mazure.* Voorspellen van landbouwop-brengsten: *J. G. W. Ignatius.* Voorspellen van productie-resultaten: *A. J. de Jong.* Samenvatting: *J. Idenburg.* (Dutch text, English summaries.)

ITALY—

Giornale degli Economisti e Annali di Economia—

January-February 1953—Scala propria, scala naturale ed invariante della funzione logistica: *L. Amoroso.* Su una funzione di ripartizione dei redditi del Mortara: *R. D'Addario.* Progetto per la costruzione di alcumi indici riguardanti scorte di prodotti finiti dell'industria italiana: *F. di Fenizio.* La metodologia statistica condizionata e la ricerca scientifica: *S. Vianelli.*

Statistica—

January-March 1953—I guadagni individuali e familiari di un gruppo di braccianti del Ravennate (Parte seconda): *A. Bellettini.* Sulle relazioni fra medie combinatorie e medie potenziate: *B. Mardessich.* Gli indici grafici della congiuntura: *F. Pedroni.* I consumi alimentari in tre gruppi di famiglie appartenenti a tre diverse categorie economiche: *L. Radi.*

April-June 1953—Statistica e calcolo delle probabilità: *B. Barberi.* Sulla graduazione intensiva: *O. Capoccia.* Di alcune relazioni lineari secondo la teoria della regressione ponderata: *G. Cusimamo.*

INTERNATIONAL—

International Labour Review—

June 1953—Collective profit-sharing: *A. Vermeulen.* Social security technique and demography: *F. Netter.*

August 1953—Population growth and living standards: *C. Clark.* The employment of handicapped workers in industry: *K. Jansson.* Some economic and social problems in Greece: *C. Elvipidis.*

Revue de l'Institut International de Statisque—

Vol. 20, No. 2/3—On the time shape of economic micro-variables and the Munich business test: *H. Theil.* Measurement of observational errors in surveys: *P. V. Sukhatme.* On the size, constitution and housing standards of households in England and Wales, 1931 and 1951: *J. W. Nixon.*

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part III, 1953, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

United Kingdom. *Agricultural Research Council.* The agricultural research service. London, H.M.S.O., 1953. vi, 54p. fold. table. 9½″. 2*s.* 6*d.*

Forestry Commission. Hedgerow and park timber and woods under five acres 1951. London, H.M.S.O., 1953. 88p. maps. 9½″. 5*s.* (Census Rep. 2.)

Census of woodlands 1947–49: woods of five acres and over. Scottish county details. v, [1], 187p. 12¾″. 10*s.* ... English county details. vi, 270p. 12¾″. 12*s.* 6*d.* London, H.M.S.O., 1953. (Census Rep. 4 and 5.)

Medical Research Council. Clinical research in relation to the National Health Service. London, H.M.S.O., 1953. 23p. 9½″. 9*d.*

Psychotic and neurotic illness in twins; by Eliot Slater with the assistance of James Shields. Statistical appendix by Joan May. London, H.M.S.O., 1953. vi, 385p. 9¾″. 21*s.* (Spec. Rep. Ser. 278.)

Plant proteins in child feeding; [by] R. F. A. Dean. London, H.M.S.O., 1953. viii, 163p. 9¾″. 10*s.* (Spec. Rep. Ser. 279.)

Ministry of Housing and Local Government. Local Government Act, 1948; report of the Committee appointed to investigate the operation of the exchequer equalisation grants in England and Wales. London, H.M.S.O., 1953. 59p. 9¾″. 2*s.*

Monopolies and Restrictive Practices Commission. Report on the supply of dental goods. ... London, H.M.S.O., 1950 [Reprinted 1953]. v, 138p. 9½″. 4*s.* 6*d.*

Scotland. Department of Health. Child health: report of the Committee on Child Health of the Scottish Health Services Council adopted by the Council in October 1952. Edinburgh, H.M.S.O., 1953. 21p. 9¾″. 9*d.*

Select Committee on Nationalised Industries. Report from the Select Committee on Nationalised Industries: together with the proceedings of the Committee, minutes of evidence and an appendix. London, H.M.S.O., 1953. xviii, 118p. 9½″. 4*s.*

University Grants Committee. University development: report on the years 1947–1952 ... London, H.M.S.O., 1953. 93p. 9½″. 3*s.* 6*d.* Cmd. 8875.

Australia. *Commonwealth Bureau of Census and Statistics.* Census of the Commonwealth of Australia. 30th June, 1947. Part XXII. Analysis of dwellings in local government areas. Queensland. Canberra, 1953. 1754–1799p. 13¼″.

Eire. *Central Statistics Office.* Census of population of Ireland 1946. Vol. II. Occupations of males and females in each province, county, county borough, urban and rural district. Dublin, Stationery Office, 1953. vii, 213p. 9¾″. 6*s.*

Food and Agriculture Organisation. The farm and the city; [by] Lawrence Witt and Mordecai Ezekiel. Rome, 1953 (London, H.M.S.O.). v, 42p. 11″. 5*s.*

Yearbook of fisheries statistics 1950–51 ... Rome, 1953 (London H.M.S.O.). xi, 296p. 11″. 17*s.* 6*d.*

Germany. *Statistisches Bundesamt.* Die nichtlandwirtschaftlichen Arbeitsstätten der Bundesrepublik Deutschland nach der Zählung vom 13.9.1950. Heft 2. Die Unternehmungen (Wirtschaftseinheiten) nach Rechtsformen und Umsatzgrössenklassen. Stuttgart-Köln, 1953. 108p. 11¾″. (Statist. Bundesrepublik Deutschland 45.)

Die kommunalen Finanzen im Rechnungsjahr 1950. Teil 1. Stuttgart-Köln, 1952. 86p. 11¾″. (S.B.D. 56.)

Norway. *Statistik Sentralbyrå.* Sosialstatistikkens historie i Norge gjennom 100 år (1850–1950). The history of social statistics in Norway during 100 years (1850–1950). Oslo, 1952. 83p. 8¾″. (Norges Offisielle Statistikk XI.113.)

United States of America. *National Bureau of Standards.* Probability tables for the analysis of extreme-value data. Washington, Supt. of Documents, 1953. iii, 32p. 10″. 25*c.* (Appl. Math. Ser. 22.)

Tables of normal probability functions:

$$\frac{1}{\sqrt{2\pi}} e^{\frac{-x^2}{2}} \quad \text{and} \quad \frac{1}{\sqrt{2\pi}} \int_{-x}^{x} e^{\frac{-\alpha^2}{2}} d\alpha$$

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Washington, Supt. of Documents, 1953. ix, 344p. 10″. $2.75. (Appl. Math. Ser. 23. A reissue of Math. Table 14, with corrections.)

World Health Organization. The African mind in health and disease: a study in ethnopsychiatry; [by] J. C. Carothers ... Geneva, 1953 (London, H.M.S.O.). 177p. 9½″. 10*s*. (Monograph Ser. 17.)

II.—AUTHORS AND MISCELLANEOUS

Anderson, (J. L.) & Dow (J. B.). Actuarial statistics ... Vol. II. Construction of mortality & other tables. 2nd ed. Cambridge, for The Institute of Actuaries and The Faculty of Actuaries, at the University Press, 1952. xvi, 281p. 8½″. 21*s*.

Anderson (S. L.) *& others*. Some rheological properties of twistless combed wool slivers; [by] S. L. Anderson, D. R. Cox and L. D. Hardy. *J. Text. Inst.* (1952), **43**, 362–379. 9¾″. Presented by the authors.

Anscombe (F. J.). Large-sample theory of sequential estimation. *Proc. Camb. Phil. Soc.* (1952), **48**, 600–607. 10¼″. Presented by the author.

Bartlett (M. S.). On the statistical estimation of mean life-times. *Phil. Mag.* (1953), **44**, 249–262.

Recurrence and first passage times. *Proc. Camb. Phil. Soc.* (1953), **49**, 263–275. 10¼″.

A sampling test of the χ^2 theory for probability chains. *Biometrika* (1952), **39**, 118–121. 10¾″.

The statistical significance of odd bits of information. *Biometrika* (1952), **39**, 228–237. 10¾″.

Stochastic processes or the statistics of change. *Appl. Statist.* (1953), **2**, 44–64. 9¾″. Presented by the author.

Beare (J. Martin) & Cheeseman (E. A.). The problem of ringworm in Northern Ireland (a survey of data collected during the period May, 1949, to July, 1951): a report to the Northern Ireland Hospitals Authority, May, 1952. *Suppl. Ulster Med. J.* (1953), **22**, 44p. 9½″. Presented by the authors.

Booth (Andrew D.) & Booth (Kathleen H. V.). Automatic digital calculators. London, Butterworth, 1953. vii, 230p. photos. 8½″. 32*s*.

Borel (Émile) & Chéron (André). Théorie mathématique du bridge à la portée de tous ... Paris, Gauthier-Villars, 1940. xviii, 392p. 10″. 900 *fr.* (Monographies des Probabilités, fasc. 5.)

Bray (F. Sewell). Four essays in accounting theory. London, Geoffrey Cumberlege, for The Incorporated Accountants' Research Committee, 1953. xi, 94p. 8½″. 15*s*.

Briggs (G. W.). Model questions and answers for the final examination of the Institute of Cost and Works Accountants. London, Gee, [1953]. 70p. 8½″. 5*s*.

Model questions and answers for the intermediate examination of the Institute of Cost and Works Accountants. London, Gee, [1953]. 75p. 8½″. 5s.

British Institute of Management. Education and training in the field of management: a survey of relevant courses and subjects at universities, technical and commercial colleges, and colleges of further education in the United Kingdom, and in the examinations of professional and educational bodies. London, 1953. 200p. 9″. 7*s*. 6*d*.

British Shareholders Trust Ltd. United Kingdom financial survey 1913–1952. London, [1953]. [3]p. 11¾″.

Cairncross (A. K.). Home and foreign investment 1870–1913; studies in capital accumulation. C.U.P., 1953. xvi, 251p. 9″. 30*s*.

Cambridge, University of. Department of Applied Economics. Sample surveys for the social accounts of the household sector; [by] J. E. G. Utting and Dorothy Cole. *Bull. Oxf. Univ. Inst. Statist.* (1953), **15**, 1–24. 9¾″. (Repr. Ser. 72.)

Conway (Freda). An index of teachers' salaries. *Bull. Oxf. Univ. Inst. Statist.* (1953), **15**, 237–248. 10″.

The industrial structure of towns. *Manchr. Sch.* (1953), **21**, 154–164. 8¾″. Presented by the author.

Cox (D. R.). Estimation by double sampling. *Biometrika* (1952), **39**, 217–227. 10¾″.

Some recent work on systematic experimental designs. *J. R. Statist. Soc.* B (1952), **14**, 211–219. 9¾″. Presented by the author.

Daily Herald. Quantuplication: a media planner's aid to the better use of the "Daily Herald" ... London [1953]. [25]p. 15″. Presented by Dr. M. K. Adler.

Desai (R. C.). Standard of living in India and Pakistan 1931–32 to 1940–41. Bombay, Popular Book Depot, 1953. xvii, 286p. 9¾″. 20 *rs*.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Dunn (C. L.), *editor*. The emergency medical services ... Vol. II. Scotland, Northern Ireland and the principal air raids on industrial centres in Great Britain. London, H.M.S.O., 1953. xii, 492p. 9½″. 50*s*. (History of the Second World War, U.K. Med. Ser.)

Fisher (Sir Ronald). Dispersion on a sphere. *Proc. R. Soc.* A (1953), **217**, 295–305. 10″. Presented by the author.

Frankel (S. Herbert). The economic impact on under-developed societies: essays on international investment and social change. Oxford, Blackwell, 1953. vii, 179p. 8¾″. 15*s*.

Gabler (Rolf). Die direkte und die derivative Indexziffer der industriellen Produktion: Grundlagen der Indextheorie und ihre Anwendung in der Praxis. Speyer, A. Leibeling, 1953. vi, 114p. 8¼″.

Garrett (Henry E.). Statistics in psychology and education ... with an introduction by R. S. Woodworth ... 4th ed. London, Longmans, Green, 1953. xii, 460p. 8½″. 30*s*.

Gokhale Institute of Politics and Economics. Report on the Poona schedules of the national sample survey (1950–51); by V. M. Dandekar. Poona, 1953. viii, 223p. 9½″. 9*s*. (Publication 26.)

Good (I. J.). The serial test for sampling numbers and other tests for randomness. *Proc. Camb. Phil. Soc.* (1953), **49**, 276–284. 10″. Presented by the author.

Green (F. H. K.) & Covell (Sir Gordon), *editors*. Medical research. London, H.M.S.O., 1953. xvi, 387p. 9½″. 40*s*. (History of the Second World War, U.K. Med. Ser.)

Hodges (J. L.) jr. & Rosenblatt (M.). Recurrence-time moments in random walks. *Pacif. J. Math.* (1953), **3**, 127–136. 10″. Presented by the authors.

International Association for Research in Income and Wealth. Income and wealth series III ... ed. by Milton Gilbert. Cambridge, Bowes & Bowes, 1953. xiii, 261p. 8½″. 35*s*.

Jackson (Willis), *editor*. Communication theory: papers read at a Symposium on "Applications of communication theory" held at the Institution of Electrical Engineers, London September 22nd–26th 1952. London, Butterworth, 1953. xii, 532p. 9¾″. 65*s*.

Kuhn (H. W.) & Tucker (A. W.), *editors*. Contributions to the theory of games. Vol. II ... Princeton University Press, 1953 (London, Geoffrey Cumberlege). viii, 395p. 10″. 25*s*. (Ann. Math. Stud. 28.) Bibliog. p. 389–395.

Ledermann (Sully). L'alcoolisation excessive et la mortalité des français. *Concours Méd.* (1953), **1619**, 28p. 10½″. Presented by the author.

Leimbacher (Werner R.). On some classes of sequential procedures for obtaining confidence intervals of given length. *Univ. Calif. Publ. Statist.*, **2**, no. 1, 1–22. 10¼″.

Luzzatto-Fegiz (Pierpaolo). La distribuzione del reddito nazionale. *G. Econ. e Ann. Econ.* (1950), luglio-Agosto, 16p. 9½″.

Luzzatto-Fegiz (Pierpaolo) & *others*. L'economia della Venezia Giulia. Università di Trieste, Istituto di Statistica, 1946. xiii, 175p. XIV maps. 9½″.

Luzzatto-Fegiz (Pierpaolo). Gli italiani e il vino: inchiesta sulle abitudini e preferenze degli adulti eseguita per conto del Ministero dell'Agricoltura e delle Foreste ... Milano, Doxa, 1952. 68p. 8½″.

The occupational evolution of a generation. *Population, Lond.* (1935), **2**, 97–107. 9½″.

Studi statistici sulle spese di un "campione" di famiglie milanesi (1952). Milano, Doxa, 1953. 32p. 8½″. Presented by the author.

Nair (K. R.). Statistical methods in forest products research. *Indian For.* (1953), **79**, 87–91. 9¾″. (Indian For. Leafl. 131.) Presented by the author.

National Bureau of Economic Research. The role of federal credit aids in residential construction; [by] Leo Grebler ... New York, 1953. 3p.l., 76p. 9″. $1. (Occ. Pap. 39. Studies in Capital Formation and Financing.)

A study of aggregate consumption functions; [by] Robert Ferber. New York, 1953. 3p.l., 72p. 11¾″ (Tech. Pap. 8.)

North Carolina, Consolidated University of. Institute of Statistics. On the distribution of the expected values of the order statistics; by Wassily Hoeffding. *Ann. Math. Statist.* (1953), **24**, 93–100. 9¾″. (Repr. Ser. 30.)

A modification of Schwarz's inequality with applications to distributions; by Sigeiti Moriguti. *Ann. Math. Statist.* (1953), **24**, 107–113. 9¾″. (Repr. Ser. 31.)

A lower bound for the average sample number of a sequential test; by Wassily Hoeffding. *Ann. Math. Statist.* (1953), **24**, 127–130. 9¾″. (Repr. Ser. 32.)

A note on rectangular lattices; by K. R. Nair. *Biometrics* (1953), **9**, 101–106. 9″. (Repr. Ser. 33.)

Pearce (S. C.) & *others*. A review of experimental design at East Malling, 1948–1952; by S. C. Pearce, G. M. Jolly, and G. H. Freeman. *Ann. Rep. E. Malling Res. Sta.* (1952), 83–87. 9¾″. Presented by the authors.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

Schacter (Nathalie) & Kiser (Clyde V.). Social and psychological factors affecting fertility. XIX. Fear of pregnancy and childbirth in relation to fertility-planning status and fertility. *Milbank Mem. Fd. Quart. Bull.* (1953), **31**, 166–215. 9″.

Society of Actuaries. Supplement to the September 1952 Report of the Society of Actuaries Committee on New Recording Means and Computing Devices, June 1953. [New York, 1953]. 4p. 11″. Presented by Mr. M. E. Davis.

Vinci (Felice). I fondamenti dell'economica. Milano, Cisalpino, 1953. 318, [1]p. 9″. 2800*l.*

Walker (Helen M.) & Lev (Joseph). Statistical inference. New York, Holt, 1953. xi, 510p. 9¼″ $6.

Walsh (R. J.) & *others*. A study of haemoglobin values in New South Wales: with observations on haematocrit and sedimentation rate values. ... Canberra, National Health and Medical Research Council, 1953. 84p. 9½″. (N.H. and M.R.C. Spec. Rep. Ser. 5.)

Wheeler (Leslie V.). Management accounting. London, Gee, 1953. 144p. 8½″. 21*s.*

Whitin (Thomson M.). The theory of inventory management. Princeton University Press, 1953 (London, Geoffrey Cumberlege). viii, 245p. 8½″. 30*s.* Bibliog. p. 231–241.

Wishart (John). The teaching of statistics. ... *Inc. Statist.* (1952), **3**, 6p. 8½″. Presented by the author.

Wold (Herman) & Juréen (Lars). Demand analysis: a study in econometrics; by Herman Wold ... in association with Lars Juréen ... New York, Wiley; Stockholm, Almqvist & Wicksell, 1953 (London, Chapman & Hall). xvi, 358p. 9″. 56*s.* Bibliog. p. 337–346.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

INDEX TO VOL. CXVI.

YEAR 1953

(Statistical and Current Notes are indicated by the letters S.N. and C.N. respectively.)

PAGE

ADDITIONS to the Library. *See* LIBRARY.
AIR transport statistics, international. *See* LESTER (A. M.)
ANALYSIS of economic time-series. *See* KENDALL (M. G.)
ANNUAL General Meeting, Proceedings of 119th 451

BANK OF ENGLAND, Weekly return, 1952 . 120–121
BELLERBY (J. R.). United Kingdom: comparison of urban and rural retail prices 47–56
- Principles of measurement . . . 47
- Retail price ratio in 1937–8 . . . 49
- Other evidence of the difference in retail prices 53
- Past and future trends in the ratio . . 55
- The future 56

BIBLIOGRAPHY of applications of mathematical statistics to economics (*Supplement for* 1950). *See* SCOTT (A. D.)
Birmingham, Annual abstract of statistics (S.N.) 219
BIRTHS, Deaths and Marriages. *See* REGISTRATION.
BOOKS. Reviews and notices of statistical and economic books:
- Adler (J. H.). The pattern of United States import trade since 1923 . . . 95
- Batchelor (J. H.). Operations research—a preliminary annotated bibliography . 209
- Blacker (C. P.) Ed. Problem families: five enquiries 217
- Bliss (C. I.). The statistics of bioassay, with special reference to the vitamins . . 459
- Booth (A. D.) and Booth (K. H. V.). Automatic digital calculators . . . 464
- Bowley (Sir A.). An elementary manual of statistics, 7th ed. 89
- British Association for the Advancement of Science. Mathematical tables, Vol. X. Bessel functions Pt. II 207
- Brookes (B. C.). Notes on the teaching of statistics in schools 203
- Brooks (C. F. P.) and Carruthers (N.). Handbook of statistical methods in meteorology 460
- Cattell (R. B.). Factor analysis: an introduction and manual for the psychologist and social scientist 462
- Census, 1951, Great Britain. One per cent. sample tables (S.N.) 102
- Chapman (A. L.) and Knight (R.). Wages and salaries in the United Kingdom, 1920–1938 210
- City of Birmingham annual abstract of statistics (S.N.) 219
- Clark (C. E.). An introduction to statistics . 461
- Coe (N. E.) and Ogborn (M. E.). The practice of life assurance 332
- Conference of British Commonwealth statisticians, Canberra, 1951. Documents, Vol. 3 (S.N.) 471
- Curtis (C. R.). Statistics as applied to accounting data 465
- David (F. N.). A statistical primer . . 325
- Doob (J. L.). Stochastic processes . . 454
- Economic Commission for Europe. Economic survey of Europe since the war (1952) (S.N.) 220
- Finney (D. J.). Introduction to statistical science in agriculture 325
- ——— Statistical methods in biological assay 85
- Food and Agriculture Organisation—European timber trends and prospects (S.N.) . 220
- Forestry Commission. Census of woodlands, 1947–1949 (S.N.) 208
- Freund (J. E.). Modern elementary statistics 205
- Gore (W. L.). Statistical methods for chemical experimentation 464
- Goulden (C. H.). Methods of statistical analysis (2nd ed.) 204
- Government of India. The National Sample Survey: General Report No. 1 (S.N.) . 471
- Hald (A.). Statistical theory with engineering applications 87
- ——— Statistical tables and formulas . 87
- Hartree (D. R.). Numerical analysis . 92
- Hicks (J. R.). The social framework. . . 93
- Hurstfield (J.). The control of raw materials 466
- International Statistical Institute. Bibliographie sur la méthode statistique et ses applications. Liste des principaux ouvrages en langue française (G. Darmois and E. Morin, compilers) (S.N.) 219
- Kuznets (Simon) and Jenks (Elizabeth). Shares of upper income groups in income and savings 465
- Lambe (C. G.). Elements of statistics . 90
- Lewis (E. E.). Methods of statistical analysis in economics and business 329
- Lundberg (E.) Ed. Income and wealth, Series I 214
- McKinsey (J. C. C.). Introduction to the theory of games 206
- Mainland (D.). Elementary medical statistics 90
- Milbank Memorial Fund. Approaches to problems of high fertility in agrarian societies 97
- Milne (W. E.). Numerical solution of differential equations 456
- Ministry of Finance, Government of India. First Report of the National Income Committee, 1951 (S.N.) 216
- Ministry of Food. Domestic food consumption and expenditure, 1950 (S.N.) . . 213
- Mounsey (J.). Introduction to statistical calculations 331
- National Bureau of Economic Research. Conference on research in business finance . 94
- National Bureau of Standards. Tables of Arctan × (2nd. ed.) 332
- ——————. Tables of Chebyshev Polynomials; Tables of the Bessel Functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$, $0 \leqslant x \leqslant 1$: Tables of Bessel-Clifford Functions of Orders Zero and One 463
- Neyman (J.) Ed. Lectures and conferences on mathematical statistics and probability, 2nd ed. 91
- Nurkse (Ragnar). Problems of capital formation in underdeveloped countries . 467
- Pearce (S. C.). Field experimentation with fruit trees and other perennial plants . 326
- Quenouille (M. H.). Associated measurements 323
- ——— The design and analysis of experiment 453
- Rao (C. R.). Advanced statistical methods in biological research 86
- *Revue de Statisitque Appliqué* (S.N.) . . 471
- Society of Actuaries. Report of committee on new recording means and computing devices (S.N.) 208
- Statistical Services of the U.S. Government (1952) (S.N.) 221

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri
110634

PAGE

Staveley (R.) Ed. Government information and the research worker . . . 209
Stoll (R. R.). Linear algebra and matrix theory 457
Stone (R.). The role of measurement in economics 92
Tintner (G.). Econometrics 206
Tippett (L. H. C.). Technological applications of statistics 88
Trumpler (R. J.) and Weaver (H. F.). Statistical astronomy 324
United Nations. World handbook of educational organisation and statistics (S.N.) . 102
——— Yearbook of international trade statistics (for 1951) (S.N.) 103
——— ———. Methods of estimating total population for current dates (S.N.) . 220
——— ———. Statistical yearbook. Demographic yearbook, 1952 (S.N.) . . 219
Waugh (A. E.). Statistical tables and problems 327

BURROWES (W. D.). The problem of exceptional samples in agricultural sample surveys 175–176
COMPARISON of urban and rural retail prices, United Kingdom. *See* BELLERBY (J. R.).
CORONATION Honours to Fellows of the Society 222
COTTON SPINNING, Statistical Investigations of Labour Productivity in. *See* TIPPETT (L. H. C.) and VINCENT (P. D.).
COUNCIL, Report of, for financial year ended Dec. 31, 1952, and sessional year ended June 24, 1953 431–450
CRIMINAL Statistics. *See* LODGE (T. S.).
CRITERION of efficiency in Local Administration. *See* LOCAL Administration.
DEANE (PHYLLIS). Regional variations in United Kingdom incomes from employment, 1948 123–135
Methods of estimation . . . 124
The regional variations . . . 127

Discussion: Mr. Ainsworth; Mr. T. M. Ridley; Mr. Colin Clark; Mr. E. J. M. Buckatzsch; Professor G. A. Barnard; Miss Deane in reply . . . 135–139

EARNINGS of operatives, 1935 and 1948. *See* LEAK (H.).
ELECTIONS to Fellowship . . 9, 34, 139, 165, 255, 271, 405, 443, 451
EMPLOYED persons—Age and regional analysis, 1952 (S.N.) . . . 334
EMPLOYMENT, incomes; regional variations in United Kingdom, 1948. *See* DEANE (PHYLLIS).
——— monthly figures . . 99, 218, 333, 470
ERRORS, the Treatment of. *See* SEERS (DUDLEY).
EXCEPTIONAL samples in agricultural surveys. *See* BURROWES (W. D.).
EXPANSION of Statistics, The. *See* FISHER (Sir RONALD).
EXPERIMENTAL study of quota sampling, An. *See* MOSER (C. A.) and STUART (A.).
FISHER (Sir RONALD), F.R.S. The Expansion of Statistics (Inaugural Address) . 1–6
Proceedings of the Meeting: Professor Bradford Hill; Sir Geoffrey Heyworth 6–9

PAGE

FOOD Statistics. *See* JONES (W. D. STEDMAN).
FRANCES WOOD Memorial Prize for competition in 1954 222
FRANKEL (H.), The price of gold and the purchasing power of the pound sterling 35–46
GILT-EDGED VALUES, Construction of an Index Number of. *See* RIX (M. S.).
GOLD, Price of, and purchasing power of the pound sterling. *See* FRANKEL (H.).

HAZLEWOOD (ARTHUR). Telecommunications statistics 191–202
History of the services . . . 191
Size of the system and traffic . . . 191
Sources of early statistics . . . 194
Employment and tariffs . . . 196
Financial statistics of the Post Office system . 196
Conclusion. Bibliography . . . 201

HILL (Professor BRADFORD), elected to Honorary Fellowship of the American Public Health Association . . . 103
HOSPITALS, Costing returns, 1951 . . 100–102
HOUBLON-NORMAN Fund, Awards for 1953–54 . . . . . 334, 471

INDEX NUMBER of Gilt-edged Values, Construction of. *See* RIX (M. S.).

INCOMES from employment, 1948. *See* DEANE (PHYLLIS).
INDUSTRIAL WAGES bill, The, and earnings of operatives in 1935 and 1948. *See* LEAK (H.).
INTELLIGENCE and parental income, A note on the relation between. *See* WALKER (A. M.).
INTERNATIONAL Air Transport statistics. *See* LESTER (A. M.).
——— Congress of Mathematicians (1954 Meeting) 222
JONES (W. D. STEDMAN), Food statistics . 57–84
Commodity statistics . . . 58
Food consumption and production . . 75
National expenditure on food . . . 79
Appendix 82
Bibliography 83

KENDALL (M. G.). The Analysis of economic time-series—Part I: Prices . . 11–25
Introduction and summary . . . 11
Data 12
Analysis of price data 12
British industrial share prices . . . 18
First experiments in trend fitting . . 23

Discussion: Professor R. G. D. Allen; Professor Champernowne; Mr. Quenouille; Mr. S. J. Prais; Professor F. Paish; Professor Bartlett; Dr. S. K. Rao; Dr. D. R. Cox; Mr. Ehrenberg; Professor Kendall in reply . . 25–36

LABOUR Productivity in Cotton Spinning, Statistical Investigations of. *See* TIPPETT (L. H. C.) and VINCENT (P. D.).
LAND in the United Kingdom, Statistics relating to the use of . . . 424–430
LEAK (H.). The Industrial Wages Bill and earnings of operatives in 1935 and 1948 275–282

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

PAGE

LESTER (A. M.). International Air Transport statistics 409–423
History 409
Present organisation 411
Standardization and comparability . . . 412
Units of measurement 413
Categories of air transport 416
Financial statistics 418
Origin and destination of passengers . . 419
Accident statistics 420
Statistics of speed 421

LIBRARY, Additions to . . 111, 229, 340, 476
LOCAL Administration, A criterion of efficiency in. Comment on the Note by K. S. Lomax (*Journal*, 1952, p. 115) and his reply 406
LODGE (T. S.). Criminal Statistics . . . 283–297
Statistical publications 283
England and Wales: Definitions and classification of offences 284
Statistics of Court Proceedings . . . 288
Interpretation of Criminal Statistics . . 290
Prison Commission statistics . . . 293
Scotland: Criminal statistics . . . 296
Bibliography 297

MACGREGOR (J. J.). Timber statistics . 298–322
Resources of home-grown timber and current policy aims 299
Supplies 305
Prices 310
Supplies and prices of imported and supplies of home-produced timber products. . 313
Stocks of timber and of timber products . 315
Consumption 315
Sources of timber statistics 319
Bibliography 320

MEDICAL Statistics, Regulations of the Study Circle on 452
MOSER (C. A.) and STUART (A.). An experimental study of quota sampling . 349–394
1. General description—quota and random sampling—design and scale of experiments—questionnaires—interview record sheets etc. 349–357
2. Response rates and completion of quotas 357–362
3. The questionnaire results—comparison of random and quota sample results—differences between towns, organizations, control levels and assignment schemes, etc. 362–385
4. Conclusions 385–388
Appendices: A and B Specimen questionnaires and interview record sheets and C industrial control 389–394

Discussion: Mr. P. G. Gray; Mr. D. Newman; Dr. H. Durant; Dr. Yates; Mr. H. Henry; Mr. M. J. R. Healy; Mr. Emmett; Mr. E. Rudd; Mr. T. Corlett; Mr. Mason; Mr. J. Moss; the authors, in reply 394–405

NATIONAL sample survey (India) . . 471

OBITUARY—
Augustus D. Webb 104
Theodore C. Taylor 104

PEAKER (G. F.). A sampling design used by the Ministry of Education . . 140–159
Specifying the population 140
Drawing the sample 141
Estimating the population mean and its sampling errors 144
The second-stage sampling variance . . 150
Qualitative variates 151
The efficiency of the design . . . 152
Another enquiry, with a further source of variance 153
Pooling opinions 153
The marking and sampling errors . . 156
Comparison of the results of the two tests . 157
Conclusions 158

Discussion: Mr. E. C. Fieller; Mr. W. J. Corlett; Dr. Sampford; Mr. Peaker in reply 159–165
PRICE of gold and purchasing power of the pound sterling. *See* FRANKEL (H.).
PRICES. Retail index numbers . 99, 218, 333, 470
——— retail (urban and rural compared). *See also* BELLERBY (J. R.).
——— wholesale. *See Statist*, Editor of.
PROBLEM of exceptional samples in agricultural surveys. *See* BURROWES (W. D.).
PURCHASING power of the pound sterling and the price of gold. *See* FRANKEL (H.).

QUOTA sampling. *See* MOSER (C. D.) and STUART (A.).

REGIONAL variations in United Kingdom incomes from employment, 1948. *See* DEANE (PHYLLIS).
REGISTRATION of the United Kingdom and Eire, 1948–52 345–348
REVENUE of the United Kingdom . . 119
RIX (M. S.). Construction of an Index Number of Gilt-edged Values . . 237–251
Summary: Some existing indicators . . 237
Yields to redemption 238
Gross and net yields 239
Yield principle 240
Constituent gilt-edged stocks . . . 241
Maturities 241
Grouping and the problem of weights . 241
Comparisons and conclusions . . . 243

Discussion: Mr. H. W. Haycocks; Professor C. F. Carter; Mr. W. F. Crick; Mr. A. F. Wootton; Miss Rix in reply 251–253

SAMPLES, Exceptional, in agricultural surveys. *See* BURROWES (W. D.).
SAMPLING design used by the Ministry of Education, A. *See* PEAKER (G. F.).
SCOTT (A. D.). Bibliography of applications of mathematical statistics to economics (*Supplement* for 1950) . 177–185
The classification systems 177
Bibliography 179
Economic classification 182
Mathematical-statistical classification . 184

SEERS (DUDLEY). The Treatment of Errors 272–274
Statist, Editor of. Wholesale Prices in 1952 186–190
Annual, monthly and quarterly index-numbers, aggregate and groups . . . 186
Average prices of each of the 45 commodities 188
Silver and gold: prices and production . 190

STATISTICAL and economic articles in recent periodicals . . 105, 223, 335, 472
——— Investigations of Labour Productivity in Cotton Spinning. *See* TIPPETT (L. H. C.) and VINCENT (P. D.).

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

PAGE

TAYLOR (Theodore Cooke). Obituary notice 104
TELECOMMUNICATIONS statistics. *See* HAZLEWOOD (ARTHUR).
TIMBER statistics. *See* MACGREGOR (J. J.).
TIME-SERIES, Analysis of economic. *See* KENDALL (M. G.).
TIPPETT (L. H. C.) and VINCENT (P. D.). Statistical Investigations of Labour in Cotton Spinning 256–267

- Description of proceeding . . . 256
- Collection of data 257
- Reduction of data 258
- Results 258
- Application of results . . . 264
- Appendix 266

PAGE

Discussion: Mr. C. T. Saunders; Dr. Easterfield; Mr. G. H. Jolly; Mr. Ryan; Dr. Rostas; the authors, in reply 267–271
TREATMENT of Errors. *See* SEERS (DUDLEY)
TRADE UNION membership numbers. . 100

UNEMPLOYMENT, monthly figures 100, 219, 333, 470
USE of Land in the United Kingdom, Statistics relating to. *See* LAND.

WALKER (A. M.). A Note on the relation between intelligence and parental income 166–174
WEBB (AUGUSTUS D.). Obituary notice . 104
WOOLTON, LORD, created a Viscount. . 222
WORK, absence from 219

PRINTED BY ADLARD AND SON, LIMITED, BARTHOLOMEW PRESS, DORKING.

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

110834
Digitized by Arya Samaj Foundation Chennai and eGangotri
सन्दर्भ ग्रन्थ
REFERENCE BOOK
Compiled
1999-2000
CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar